POWER

Volume 65 New York, January 25, 1927 *Number* 4

Have Things Handy

HAVE things handy. Many a good idea is not carried out because it is not done at once—because the turn of a hand would not do it.

How much easier the day's work would be, how much more we could get done and with how much less effort if we had things handy!

It often takes more time and work to get at a job than it does to do it.

And there are so many helpful things available nowadays that we are led to wonder how people ever got through without them. Imagine a modern business or professional man obliged to conduct his correspondence personally with a quill pen and without the benefit of the modern office equipment.

Much of the difference between an efficient and a mediocre man is that the latter spends a lot of time looking for things and working with inferior tools and appliances, while the other is getting things done.

In some shops and offices and houses that one goes into, this fact of handiness is very evident. Somebody has done some thinking in their laying out.

But however handy houses or offices or homes may be, it is of no use unless those who live in and use them are orderly and disposed and interested to take advantage of the opportunities that they offer to make things easy.

And then there are places and things that are not so handy. Just notice how much easier some trivial operation through which you often go might be made with a little different arrangement.

F. R. Low

Using Meters Improves Efficiency and Reduces Investments

By H. W. GOCHNAUER
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IN THE author's plant, steam-flow meters were installed in 1921. By using the information made available by these meters, it has been possible to increase the boilers' rating greatly and at the same time improve the evaporation per pound of coal on an average of about 33 per cent. Not only has this resulted in larger savings in operating costs, but it has allowed supplying a large increase in steam demands without enlarging the plant, as would have otherwise been necessary.

PRODUCTION and consumption records of steam and electrical energy are valuable from three distinct viewpoints: By knowing the quantities of steam power used it is possible to operate in such a manner that a direct saving is effected; the operators and attendants can use more skill in their art with graphic records constantly before them, and this will result in a better product. The accounting is far more accurate when the actual quantities of steam and power consumed are known. This last is especially true where several kinds or grades of a product are manufactured. When one realizes that power costs in a paper mill are 25 per cent of the total conversion cost, the importance of proper metering is evident.

When meters are first installed, the operator feels that his work is being checked and that any subsequent suggestions are unwarranted criticisms. However, with a little diplomacy and friendly co-operation, he is quite easily won over, and in a short time is using the equipment to better the results of his labors. In fact, the operator generally becomes so dependent on the equipment that he is at a loss when it is not available for his use.

The Northern Paper Mills are entirely equipped with steam and electric meters. It is the duty of one of the assistants in the engineering department to take care of and read all meters. In addition to this work he compiles the records and aids the operators in the correction of unnecessary power and steam consumption. In this manner a constant check on the power and steam requirements throughout the mills is maintained.

The electric meters are distributed in such a manner that segregation of costs is readily obtained. Rather than take tests on blocks of power by use of electric meters, individual tests are made on each motor. In this manner the load characteristics and other pertinent data are collected, and if the machine is found to be an improper one for the work it has to perform, another is installed in its place. It is of interest that a power factor averaging between 85 and 90 per cent is maintained, which is very satisfactory for a manufacturing industry. Steam-flow meters are installed on each of the seven boilers and on the three outgoing steam headers to the mills. Steam is also measured to the three digesters, the bleach plant, the six paper machines, steam turbine and mill-heating system. Electrical power consumption is also measured to the various units. Fig. 1 shows graphically the location of the steam-flow meters *M* and the feed-water meter *W*.

The steam produced by the boiler plant is checked roughly in two ways. First, by comparing the total steam production with the feed-water consumption, the latter being measured by means of a venturi meter; and, second, by comparing the total production as obtained from the individual boiler meters, with the total of the outgoing meters *A*, *B* and *C* on the distributing headers, as shown in Fig. 1.

The boilers are equipped with integrating, recording and indicating meters; the latter are mounted on the boiler fronts and are calibrated in boiler horsepower. A red mark on the dial aids the fireman in holding the desired rating on each boiler.

Coal is weighed to each boiler by means of a weigh larry operated in conjunction with an overhead bunker, and the weigh tickets are totaled and recorded for each shift. The meters are also read for each shift, from which combined record is calculated the pounds of steam per pound of coal as fired for each boiler. From these records one can see at a glance how each boiler was operated for each shift.

Originally, to provide friendly competition, a chart was prepared on which was plotted daily in color the pounds of steam per pound of coal for each shift. As a result of this procedure it was noted at one time that

one shift was always low. On further investigation it was found that a second fireman was not "measuring up." The head fireman knew of the situation, but rather than complain, worked harder to hold the steam pressure with the boilers assigned to him. He little realized that there was an appreciable loss to the organization through the faulty operation of the other boilers.

Competition became so keen with this system, however, that coal weights were found incorrect. This may have been done to better the results and beat the records of the other shifts.

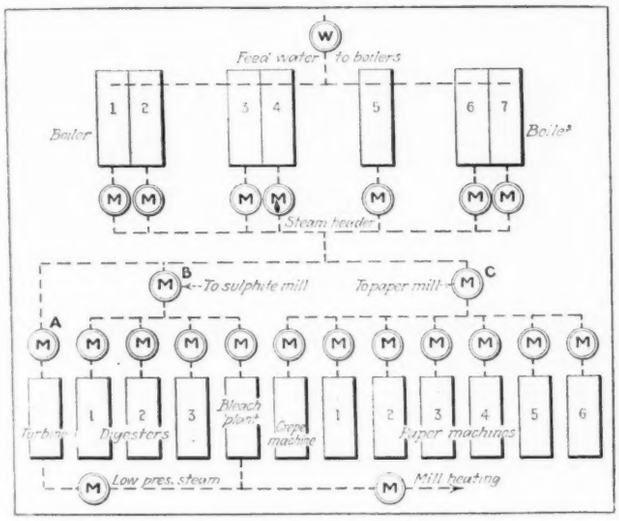


Fig. 1—Location of steam-flow meters

A rather interesting condition became apparent about this time. It was noted that the pounds of steam per pound of coal varied with the rating, and that an average rating of about 175 to 200 per cent should be maintained for the most efficient results. A curve showing how the evaporation varies with rating is given in Fig. 3. The boiler-room competitive chart was then changed to a boiler rating record, and in this manner the desired results were obtained without reference to the coal fired or the steam generated. It is difficult to hold a high rating unless the fires are kept in proper condition, and thus competition was carried on, good efficiency was obtained, and there was no incentive for the firemen to beat the records. It is interesting to compare the charts showing the boiler operation when the meters were first placed in service and the present charts. Fig. 4 shows a chart taken from boiler No. 6, Dec. 8, 1921, and Fig. 5 a steam-flow chart taken from the same boiler June 30, 1926. In the former the average rating was 153 per cent and the evaporation 7.18 lb. of water per pound of coal. For Fig. 5 the average boiler rating is 201 per cent and the evaporation 8.86 lb. The same general relation exists for the steam-flow chart taken from all the boilers for 1921 and for 1926, except that in 1921 the evaporation was in general lower than that given for the chart, Fig. 4, where the 1926 chart gives a fair average condition.

The 1921 charts were taken when the flow meters were first installed and no use was being made of these meters in the boiler room. The conditions were corrected as soon as we taught the firemen how to use the flow meters, and since then we have had no repetition of the highly fluctuating results obtained when this work was first started. The difference in the quantity of steam per pound of coal is not entirely due to the installation of flow meters, but in part to improvements made in the boiler plant during these years. About a year ago the furnaces were entirely rebuilt and put in first-class condition, and since that time we have put in an induced-draft fan which has materially aided in improving the efficiency. Thus it is difficult to determine just what credit should be given the flow-meter equipment. This is a question that is debatable because grades of coal often change from year to year.

When the steam-flow meters were first installed, the boilers were operated in general around normal rating, but as a result of the data obtained and plotted, as shown in Fig. 3, the average rating was increased to between 175 and 200 per cent of normal. This sharp increase in output has not decreased the life of the boiler setting or furnaces. On the other hand, it has so increased the capacity of the plant that no additional boiler capacity has been needed to keep pace with the rapid strides made in the production of the mills. Thus the results of analyses made from steam-flow meter records not only resulted in a saving of fuel, but also has saved a large initial investment.

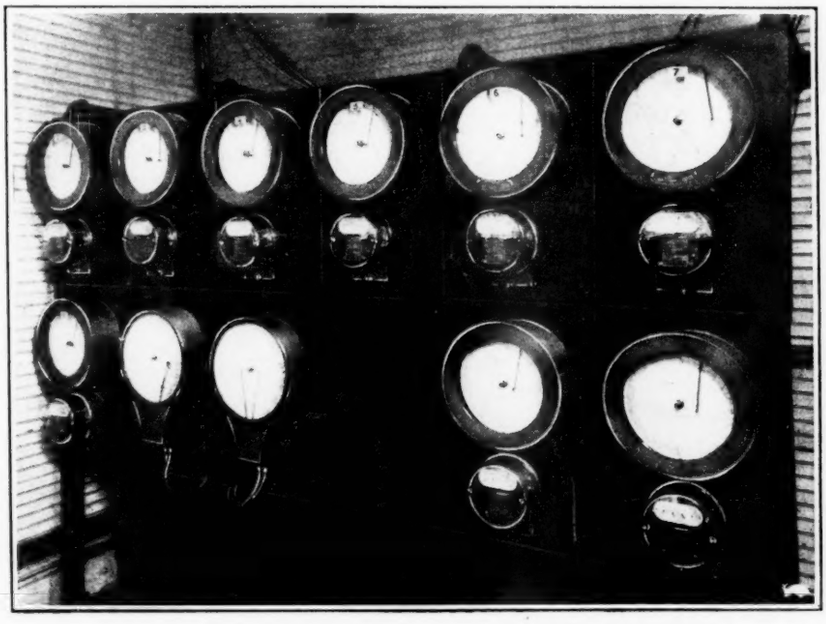


Fig. 2—Boiler-room meter board

Originally, it was deemed necessary to drift one boiler so that it would be available as a spare on short notice. A drifted boiler consumes a large amount of coal and produces no steam except when called upon. Complete flow-meter readings made it possible to bank the spare boiler, using very little coal and at the same time retaining the emergency use

of the boiler. This change of operating technique was made possible through the fireman's ability to foresee adverse conditions by the aid of the meters.

Steam-Turbine Generator Unit

A steam-turbine generator unit of the extraction type produces about half the electrical power consumed. This unit has been described in a former article (*Power*, May 11, 1926). A steam-flow meter is installed on the high-pressure line too, and on the low-pressure extrac-

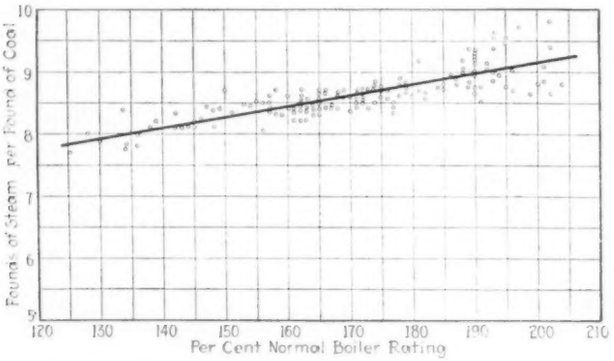


Fig. 3—Evaporation increases with boiler rating

tion line from the unit. The steam to the turbine is checked by measuring the condensate over a V-notch weir when the turbine is operating total condensing. The extraction meter is checked by measuring the condensate in conjunction with the turbine meter after the latter has been calibrated.

Steam-flow meters in this instance are valuable, first, to obtain the correct steam cost chargeable to the unit,

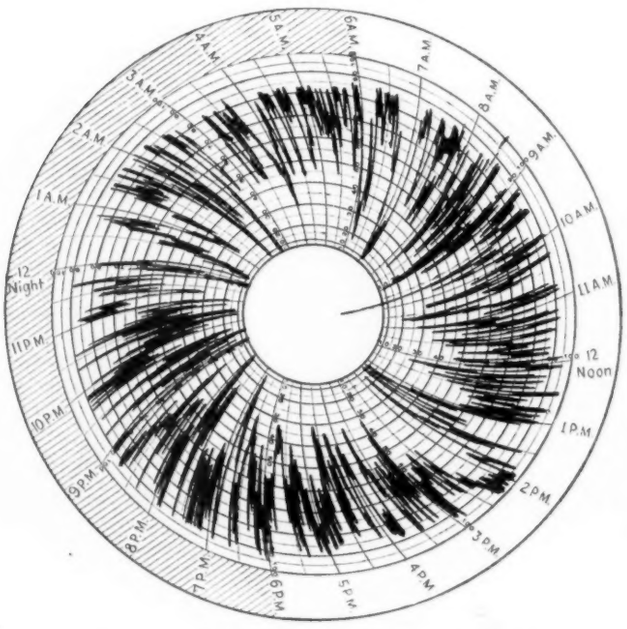


Fig. 4—Steam-flow chart taken in 1921

and second, to note any gradual decrease in the efficiency of the machine. In the latter case it is possible to balance the power loss due to decreased efficiency against the cost of reblading and thus estimate the proper time to make the repairs.

The bulk of the steam used in the sulphide mill is consumed in three digesters. Each is equipped with a steam-flow meter, which, used in conjunction with the temperature recorder, makes a valuable instrument for the cooks and indispensable records for the superintendent.

Recently, the consumption of steam was erratic, causing an extra burden on the boiler plant and an in-

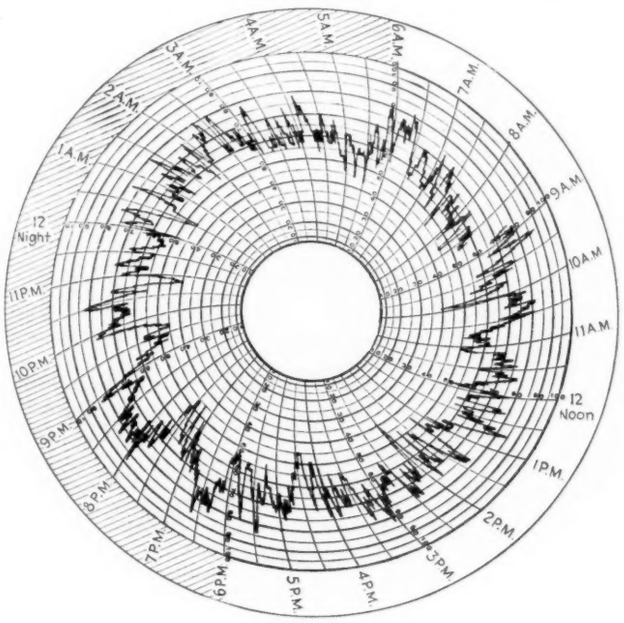


Fig. 5—Steam-flow chart taken in 1926

creased steam cost to the digester. This condition would not have been realized except for the charts, one of which is shown in Fig. 6, from which it was perfectly evident that the automatic regulators were not functioning properly. There was no disputing this fact when the charts were offered as witnesses. The valves were replaced and the trouble and waste were ended.

The six paper and the crepe machines are equipped with steam-flow meters mounted near the machines, and a daily record is kept of the steam consumed by each shift on each machine. The machine tender soon learns that a certain amount of steam is required to make a specific grade of paper, and he watches the chart as he adjusts the valve. In this manner he has an indication of the amount of steam flowing to the machine and the old cut-and-try method, often resulting in a too wet or a too dry paper, is done away with. The machine conditions, such as the age of the felts, etc., are factors, however, which make it impossible to hold an absolute specific quantity of steam for a definite grade of paper.

Meters are also useful in determining the value of new equipment which may be added to the machines from time to time such as traps, vacuum pumps and drying systems. The paper machine steam-flow meters are tested by collecting and weighing the condensate from the driers.

Very interesting stories are written in the paper-machine charts. At one time, owing to a certain condition of short duration, an order was issued to blow the cylinders with steam at specified intervals. The chart recorded exactly the time and duration of this operation. It is customary to turn some live steam into the driers to warm them up on Monday mornings, which facilitates starting promptly on the new week's run.

On one occasion the valve had been left open until the fact was noted on the chart. Had this condition not been recorded, the live steam would have replaced the exhaust steam for the ensuing week and the latter would have been wasted.

At another time, when there were disputes over the proper ringing of an important electric signal bell, the

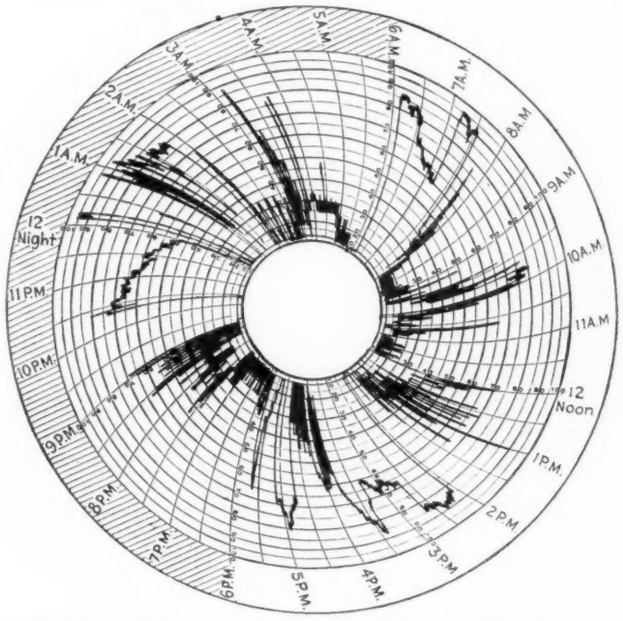


Fig. 6—Steam-flow chart shows that automatic regulator was not working properly

difficulty was settled with a flow meter. A recording instrument was connected into the circuit and a graphic record was thus obtained whenever the gong was sounded, eliminating all dispute as to whether or not it had been rung.

Meters are valuable as watch dogs, constantly alert to prevent needless waste. They are ceaseless, inoffensive drivers. They proclaim errors in faulty operation and often protect the innocent. They lead the way to better products and more efficient operation. They establish at times a goal, a high mark which is valuable as a record to "shoot at." They prepare the way for friendly competition, which injects a touch of "the game" into a man's routine of work. And, finally, their presence is, in short, indicative of good management.

An Example of Improved Boiler Efficiency

BY M. EHRLICH*

In view of the frequency with which engineers have to contend with the indifference of executives, it is a pleasure to place on record a notable improvement in boiler efficiency at the South Works of the National Lead Company. This was made possible because the efforts of the writer as chief engineer were backed by the general superintendent of the plant, G. D. Marsh.

He, being an engineer of long experience, readily recognized that certain changes would improve the performance of the boilers. It was due to his persistent efforts that the changes were made possible and, further, his aid made the changes a success.

*Chief engineer, South Works, National Lead Co., Chicago, Ill.

The increase in the efficiency of the boiler was so remarkable that it is worthy of note. The boiler in question is a horizontal water-tube unit with 2,500 sq.ft. of heating surface. It was originally set 6 ft. above a horizontal underfeed stoker. The change consisted in raising the boiler 2 ft. 7 in., changing the baffling from horizontal to vertical and introducing a high-temperature insulator in the setting. Under normal conditions this boiler is operated at about 200 per cent of rating.

TESTS SHOW IMPROVED PERFORMANCE

Two tests of 30 days' duration each were conducted, test 1 under the old setting and test 2 on the changed setting. The same conditions prevailed and the same fuel was used for each test. The results of the tests, as given herewith, were corrected for every possible error in the meter equipment, the same factors for correction being used in both tests.

RESULTS OF TWO THIRTY-DAY TESTS

Fuel Used

Fourth vein, Midland, Ind., 1¼—2-in. nut

Analysis

Carbon, per cent	50.50
Volatile, per cent	33.36
Moisture, per cent	6.15
Ash, per cent	8.20
Sulphur, per cent	1.79
	100.0

Heat value, B.t.u. per pound, as fired, 12,420

	30-Day Test Made	
Average Pressures	Before	After
Steam pressure by gage, lb. per sq.in.	123.5	130.3
Draft at uptake damper, in. water	0.67	0.28
Draft over fire, in. water	0.43	0.12
Difference in draft between uptake damper and fire, in water	0.24	0.16
Blast under fire, in water	2.2	1.8
Average Temperatures, Deg. F.		
Feed Water	204.5	206.3
Escaping flue gases	747	469
Feed Water	Before	After
Water pumped to boilers, lb.	6,271,100	6,874,700
Less blowdown, lb.	555,000	508,100
Actual water evaporated, lb.	5,716,100	6,366,600
Equivalent evaporation, lb.	6,006,000	6,682,000
Factor of evaporation	1.0507	1.0496
Fuel		
Coal supplied to furnace, lb.	827,390	696,750
Economic Results		
Average CO_2, per cent	6	11
Actual water evaporated per lb. coal as fired, lb.	6.9	9.10
Equivalent evaporation per lb. coal as fired, lb.	7.25	9.55
Efficiency of boiler, furnace and grate, per cent	56.5	74.5

What caused the greatest change in the boiler and furnace efficiency is hard to calculate. Some of the savings may be attributed to the following changes: (1) Increasing the heating surface of the boiler in contact with the hot gases of combustion 233 sq.ft., by removing the tile from the tubes that were partly or entirely covered; (2) eliminating pockets for the accumulation of soot over baffle tiles; (3) reducing the stratification of the gases, resulting in better combustion; (4) eliminating gas pockets; (5) increasing combustion space directly over fire bed; (6) increasing the circulation of the water in the boiler; (7) reducing radiation by insulating the setting.

In connection with item 6 it is interesting to note that with a room temperature of 80 deg. the average difference in temperature between the setting of the old boiler and the room was 125 deg., while the difference in the new setting is about 80 deg. for one-fourth of the surface, the remainder of the surface having a temperature of the room.

Finally, it should not be forgotten that increased skill in operation has played as important a part as any of the physical changes made in the equipment.

Precooling Liquid Ammonia*

Methods Used To Precool Liquid Ammonia Before It Reaches the Evaporator in Single and Multi-Stage Plants, and the Saving To Be Anticipated

By WILLIAM JAHNKE

TO PRECOOL liquid ammonia before it reaches the expansion valve, the following three methods have been used: First, passing the liquid from the ammonia receiver through a coil in the accumulator shell on its way to the expansion valve, as is frequently done in a single-stage compression plant; second, using ammonia intercooling in a two-stage compression plant; third, by the installation of a suitable interchanger whereby the comparatively warm liquid gives up its heat to water of a lower temperature.

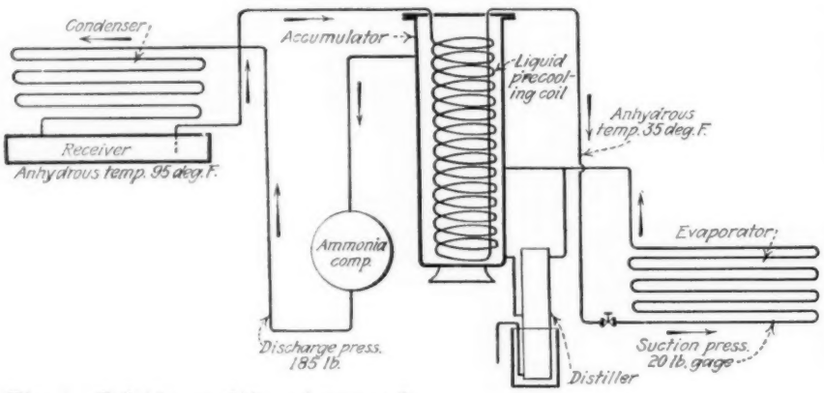


Fig. 1—Relative position of accumulator in single-stage compression plant

In the first method, which is shown in diagram in Fig. 1, the liquid ammonia on its way from the receiver to the evaporator passes through a spiral coil placed in the accumulator, through which passes the ammonia vapor on its way from the evaporator to the compressor. By the cooler vapor in the accumulator the liquid ammonia is precooled from a temperature corresponding to the condenser pressure to a temperature about 20 deg. higher than that corresponding to the evaporator pressure. When it is considered that, without this precooling, about 17 per cent of the liquid must be evaporated at the expansion valve to cool the liquid from a temperature corresponding to 185 lb. to a temperature corresponding to a pressure of 20 lb. in the evaporator, and that the vapor from this 17 per cent of the liquid gasifies at the expansion valve and in passing through the evaporator diminishes its available surface, it is not hard to see the good accomplished by precooling the liquid as outlined by the diagram in Fig. 1.

Another method of precooling liquid is that employed in the multi-stage compressor plant. As shown in diagram in Fig. 2, the liquid ammonia on its way from the receiver to the evaporator passes through a coil inserted in a suitable shell that is located between the low-pressure and high-pressure cylinders. Its construction is similar to that of an accumulator except that the piping arrangement differs, as no ammonia gas passes through except that expanded directly into it for the purpose of precooling the liquid in the coil and to reduce the temperature of the discharge of the low-pressure machine nearly to its saturation point.

Referring to Fig. 2, it will be seen that at the top of the shell a gas outlet line connects to the suction line of the high-pressure cylinder. A small liquid line bypassed from the main liquid line connects to the liquid cooler near the bottom. The amount of liquid expanded into the cooler is controlled by an expansion valve. Upon entering the shell the liquid ammonia is reduced in pressure corresponding to that in the high-pressure suction line and its temperature is reduced correspondingly.

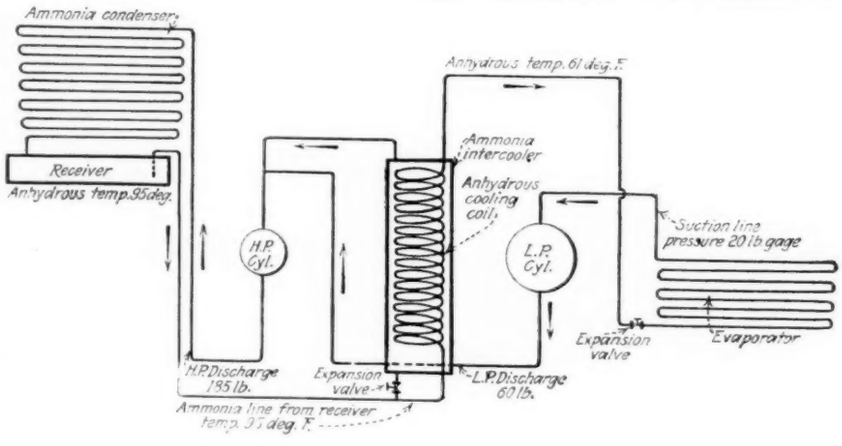


Fig. 2—Location of liquid ammonia cooler in multiple-compression plant

Assuming a discharge pressure of 185 lb. gage, the ammonia liquid temperature corresponding is 95 deg. F. At this temperature the liquid enters the coil in the precooler. With a pressure of 65 lb. in the precooler, the corresponding temperature is 44 deg. F. Assuming that the proportion of the coil is such that the liquid will be cooled to within 20 deg. F. of the temperature

*Abstract of paper read before the seventeenth annual convention of the National Association of Practical Refrigerating Engineers, Kansas City, Mo.

in the shell, the temperature of the liquid leaving the coil would be 64 deg. F., and the difference in temperature of the liquid entering and leaving the coil would be 31 deg. F.

Under the assumed condition that 42 lb. of liquid ammonia must be expanded per minute to produce 100 tons of refrigeration, the tons of refrigeration equivalent to the cooling in the precooler may be obtained as follows:

Heat Removed by Precooling

The B.t.u. removed by precooling the liquid equals $31 \times 42 \times 1.1 = 1{,}432$, where 1.1 is taken as the specific heat of liquid ammonia. The removal of 1,432 B.t.u. per min. is equivalent to $1{,}432 \div 200 = 7.16$ tons of refrigeration, constituting in this case 7.16 per cent of the capacity. In other words, it may be stated that the installation and operation of the precooler has increased the capacity of the evaporator 7.16 per cent, or instead of getting 100 tons of refrigeration, by precooling the liquid 107 tons is produced.

Using low-temperature water in a special precooler constitutes the third method to which previous reference has been made. A portion of a double-pipe counter-current condenser makes an excellent precooler. This may consist of 2- and 1¼-in. pipes, with the liquid flowing through the larger pipe and the water through the 1¼-in. pipe. In an installation of this character the rate of heat flow is about 100 B.t.u. per min. per square foot per degree temperature difference.

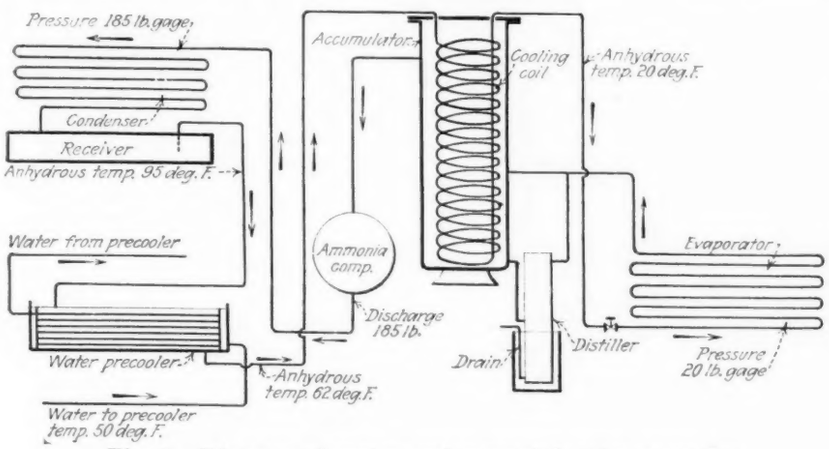


Fig. 3—Diagram of system using special water precooler and also an accumulator

Surface Needed in Precooler

Consider a 100-ton refrigerating plant operating under the pressures and temperatures shown in Fig. 3. Assume that a small amount of water at 50 deg. F. is available for precooling and that this water leaves the precooler at 58 deg. F. The installation is made counter-current so that the outgoing liquid meets the incoming water. It will be of interest to determine how many lineal feet will be required in this liquid cooler to cool the liquid ammonia from 95 to 62 deg. F., how much water will be needed and the percentage of saving effected. The heat that must be removed per minute will amount to $42 \times (95 - 62) \times 1.1 = 1{,}525$ B.t.u. Then as the heat transfer is 100 B.t.u. per square foot, the area of cooling surface required would amount to $1{,}525 \div 100 = 15.25$ sq.ft., and as 2.3 lin.ft. of 1¼-in. pipe has 1 sq.ft. of cooling surface, $15.25 \times 2.3 = 35.07$ lin.ft. of pipe will be required in the cooler, or practically two lengths of condenser pipe. The amount of water needed in gallons per minute is $1{,}525 \div (8 \times 8.33 \times 0.9) = 25.4$, the 0.9, or 90 per cent, representing the efficiency of heat transfer.

If the entire pumpage is 350 gal. of water per minute and 5 per cent of this is allowed for wastage by evaporation, then 17½ of the 25 gal. required by the cooler could be used to supplement the main supply, or the entire amount used by wastage of a little of the warmer water.

Gain in Capacity

It may be of interest to consider the loss from the liquid vaporized at the expansion valve to reduce the temperature from 95 to 5 deg., and the reduction of this waste by precooling the liquid from 95 to 62 deg. F. The B.t.u. content at the different temperatures given is as follows:

Heat content of liquid at 95 deg. = 149.4 B.t.u.
Heat content of liquid at 62 deg. = 111.5 B.t.u.
Heat content of liquid at 5 deg. = 48.3 B.t.u.

The difference in heat content of the liquid at 95 and 5 deg. is $149.4 - 48.3 = 101.1$ B.t.u., and as 42 lb. of ammonia is being expanded per minute, this difference in heat content is equivalent to $42 \times 101.1 \div 200 = 21.23$ tons of refrigeration. The difference in heat content of the liquid at 95 and 62 deg. is $149.4 = 111.5 = 37.9$ B.t.u., and proceeding as before, $42 \times 37.9 \div 200 = 7.96$ tons of refrigeration. Then $7.96 \div 21.2 = 0.375$, or a saving of 37.5 per cent of the loss has been effected by precooling.

Another point of interest is to determine the increase in the compressor capacity obtained by precooling. The total heat of saturated ammonia vapor at 20 lb. gage and 5 deg. F. is 613.3. In the liquid at 95 deg. F. there are 149.4 B.t.u., at 62 deg. there are 111.5 and at 5 deg. there are 48.3 B.t.u. Then $613.3 - 149.4 = 463.9$ B.t.u. are available for refrigeration in the first case and $613.3 - 111.5 = 501.8$ B.t.u. are available in the second case, and $613.3 - 48.3 = 565$ B.t.u. in the case where the liquid is precooled to 5 deg. F. Then $(200 \div 463.9) \times 8.15 = 3.5$ cu.ft. of vapor must be handled per ton of refrigeration if no precooling is done. In this equation 8.15 is the volume in cubic feet of one pound of ammonia vapor at 20 lb. gage and 5 deg. F.

If the liquid is precooled to 62 deg., we have $(200 \div 501.8) \times 8.15 = 3.25$ cu.ft. per ton of refrigeration to be evaporated in the coils and handled by the compressor. The saving in compressor capacity is then $(3.5 - 3.25) \div 3.5 = 0.071$, or 7.1 per cent.

This will allow a reduction of compressor speed by this percentage without losing any refrigeration, or with a compressor at the same speed the production of 7.3 additional tons of refrigeration.

It is generally stated that for every 10 deg. F. of liquid precooling by water a saving of 2.5 per cent is made. Good practice requires the installation of some design of precooler.

How Steam-Turbine Generator Windings Are Insulated

DESCRIBES the materials used, method of making the coils and how the insulation is applied and treated to withstand the high mechanical forces and wide changes of temperature to which these windings are subjected.

By M. D. ROSS
Power Engineer, Westinghouse Electric & Manufacturing Co.

WITH large units, a shutdown of one involves the loss of a considerable portion of the generating capacity of the system and a consequent decrease in the earnings of the equipment. In modern turbine generators every effort is therefore made to decrease failures to a minimum. Within recent years one of the chief improvements in this respect has been made in the design of insulation for stator and rotor windings.

At present, turbine generators are manufactured for stator voltages between 180 and 13,800 volts. The range of stator voltage for a given frame depends upon the size of machine. Thus, about 3,300 volts is the maximum economical voltage for the smallest machines, while the largest sizes cannot be built for lower than 6,600 volts. A number of 11,000-volt single-phase generators have been built for railway service, where one end of the winding is grounded. In this case the stator insulation must be equivalent to that of a 19,000-volt three-phase machine. The maximum rotor excitation voltage so far used is 250 volts.

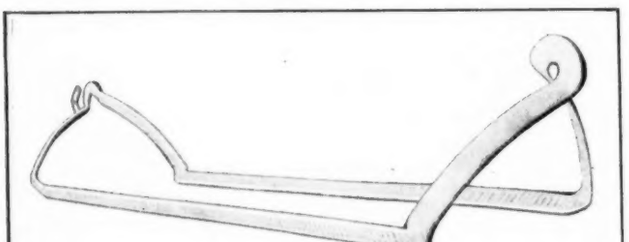


Fig. 1—Coil for large steam-turbine-driven generator

Wherever possible mica is used as an insulating material for the turbine generator, as it is by far the best material for such purposes. Fibrous materials, such as cotton and treated tape, show a rapid decrease in dielectric strength when subjected to temperatures higher than 105 deg. C., whereas built-up mica shows practically no difference in dielectric strength up to quite high temperatures. With generator voltages above 10,000 volts electrostatic stresses sufficiently high to break down air often occur, particularly at points and corners at ground potential such as the edges of projecting laminations and edges of core ventilating ducts. The static or corona that results is accompanied by the formation of nitrous oxide and nitric-acid gases, which are injurious to cotton or treated cloth, but have no effect upon mica.

For certain reasons mica cannot be used for several parts of the insulation. However, the conditions to be met with in these parts are such that the properties of mica are not required and other materials can be used satisfactorily.

All turbine-generator stator coils are of the diamond type, Fig. 1, and are arranged to be wound in open slots. The insulation of the stator coils can be divided into three main parts:

A. The insulation of the individual strands in the conductor. Each conductor is made up of a number of relatively small strands, connected in parallel at the ends of the coil and insulated from one another to reduce the eddy-current losses in the conductor to a minimum.

B. The insulation on each conductor. In a multi-turn coil the conductors must be suitably insulated to withstand the potential between adjacent turns.

C. The coil insulation applied over the conductors which must be able to withstand the full potential between copper and ground.

Large Generator Coils

Coils for the larger turbine generators are made by forming bare-copper ribbons on a wooden mold or former to their final shape. Each strand of the conductor is then taped throughout its whole length with mica tape, which forms the insulation between strands to reduce eddy currents. Mica tape is made by building up mica splittings on a strip of thin paper which holds the mica together while it is being applied to the coil. While the voltage between strands, tending to produce eddy currents in the conductor, is quite low, the insulation must be such that mechanical separation is insured throughout the life of the generator.

In the case of a multi-turn coil the strands in each conductor are next tightly taped together with a single layer of thin cotton tape and the whole conductor is given a covering of mica tape throughout its length. This provides the insulation between adjacent conductors.

Several conductors are bound together into one unit by another layer of cotton binding tape. After certain impregnating processes to eliminate air pockets in the coil and to stiffen it for the remainder of the assembly, the coil is then ready for the insulation of the embedded or straight portion. The wrapper used for insulating this part of the coil is composed of mica splittings built up on sheets of thin paper. These sheets are made several inches longer than the stator iron and are arranged so that, when applied to the coil, the wrapper is tapered off at each end beyond the embedded portion.

After putting the wrapper on loosely by hand, the coil is placed in a special wrapping machine which tightens the insulation. In this machine a number of

electrically heated plates revolve about the wrapper and press against it with considerable pressure so that the different layers of the loose wrapper slide upon one another and become tighter on the coil as the process goes on. The hot plates soften the bonding material in the wrapper so that when the tightening process is completed the insulating wall is a hard compact mass with practically no air spaces between the layers of mica.

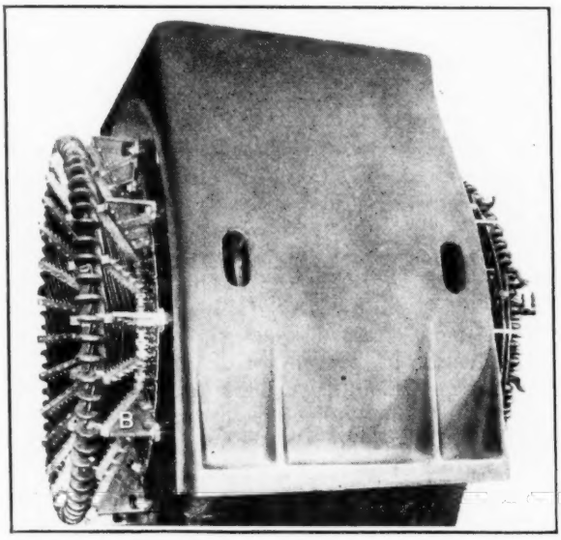


Fig. 2—Bracing of end windings of a large turbine generator

An insulating wall of this type occupies a minimum of space in the slot for a given voltage and provides a relatively easy path for heat flow from the copper to the iron due to the absence of air pockets between layers. The percentage of mica in such a wrapper is high. While certain amounts of cotton and paper materials are used in the insulation of the embedded portion of the coil, they merely serve to hold the mica while assembling the insulation and could be entirely destroyed without affecting the insulating qualities of the wrapper.

Insulation of the Coil Ends

The coil ends must be insulated in a somewhat different manner from the embedded parts. The shape of the coil ends is such that a material that can be applied to the curved surfaces must be used. Owing to the small number of poles the angle between slots to take the two sides of the coil is appreciable, and the coil must be bent somewhat in placing it in the slots. The insulation of the coil ends must be flexible enough to stand the bending. The coil ends are therefore insulated over the mica tape conductor and strand insulation, with a number of layers of treated tape with a coat of varnish on each layer as it is applied.

The joint between the tape and the tapered end of the insulation on the straight part of the coil is sealed with compound so that the insulation of the whole coil is moisture and dustproof. The treated tape is covered with several layers of cotton tape to provide protection against mechanical injury to the coil end insulation. While treated tape does not have the insulating qualities at high temperatures that mica has, the temperatures obtained in the end windings are relatively low owing to the direct contact of the cooling air upon the outer surface of the coil insulation, and are well below the critical temperature for class *A* materials as defined by the American Institute of Electrical Engineers Standards.

Insulation of the stator coils for machines under 5,000-kva. rating, with voltages not exceeding 6,600, is somewhat different from that of the larger sizes. Owing to their small size and low voltage these coils lend themselves well to a different method of manufacture. The conductor is made up of a number of cotton-covered ribbons which are wound on two round pins or shuttles. The coil is then clamped in a special machine and is pulled into its final shape in one operation. The insulation processes are the same as for the large coils except that the double-cotton covering on the individual ribbons forms the strand insulation and the wrappers on the straight portions of the coil are applied by hand and are not machine wrapped.

When winding the coils in the stator, treated paper cells are first placed in the slots to protect the coils from the laminations. As the coils are being wound, the temperature detectors are installed, usually between top and bottom coil sides and adjacent to the top coil, where a filling strip is used between top and bottom sides. A strip of fiber is placed above the top coil side in the slot and the stator wedges are driven in place over it.

Bracing the Coil Ends

In the larger coils a set of wood blocks are next roped in place between coil ends adjacent to the core. Triangular steel braces *B* are bolted to the stator, and the coil ends are bolted to these braces by means of wood blocks as shown in Fig. 2. This construction provides ample strength to withstand the forces set up in the

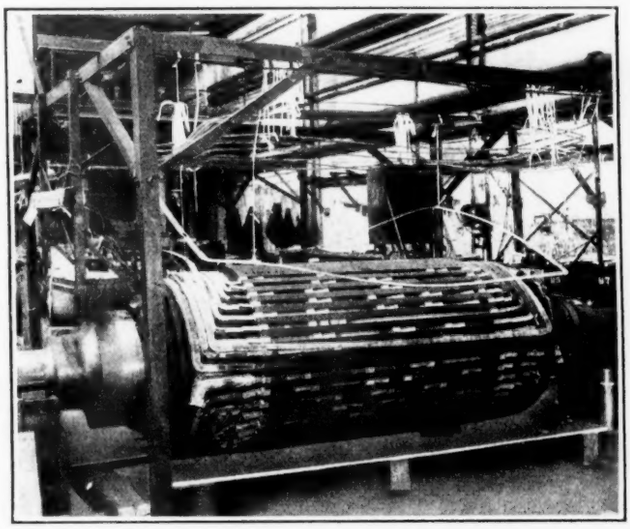


Fig. 3—Rotor in process of winding

end windings during heavy short-circuits. The smaller machines with much lower forces in the end windings on short-circuit, are provided with insulated steel rings supported by brackets on the ends of the frame to which the coil ends are roped securely.

Tests during manufacture are given the armature coils and winding to insure against insulation failures when in service. When the coil insulation is completed,

each coil is given three tests. The first consists of a potential test between adjacent strands to detect any defects in strand insulation. The second test is a potential test between turns when the coil has more than one turn. It is carried out on a high-frequency testing apparatus designed to give a high potential difference between turns on the coil, and any breakdown can be readily detected with this equipment. Steel cells are

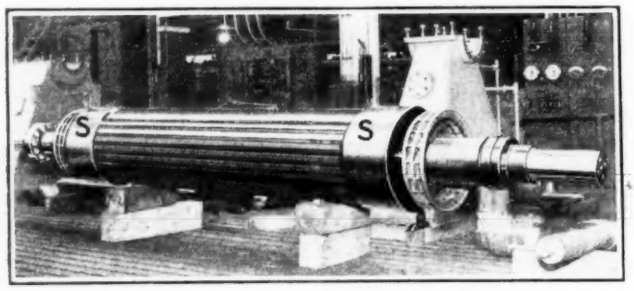


Fig. 4—Complete rotor for high-speed alternator

placed around the straight part of the coil for the third test, and voltage is applied between conductors and the steel cells. As the coils are assembled in the machines, they are usually tested again in groups to detect any defects in winding. The final tests are made with the winding completed and consist of tests between phase groups and between windings and ground.

Insulating the Rotor Coils

Insulating the rotor of a turbine generator presents a number of problems which are chiefly of a mechanical nature. As the maximum excitation voltage is 250 volts, the insulation of the rotor coils for such a voltage would be relatively simple if it were not for certain conditions that tend to break down the mechanical structure of the materials. The peripheral speed of the outer surface of large turbo-alternator rotors is as high as 26,000 ft. per min. The pressure of the rotor coils upon the insulation at such peripheral speeds may be as high as 4,000 lb. per sq.in. The rotor windings operate at temperatures varying from that of the room to 150 deg. C., and the expansion of a long rotor coil with such a change in temperature is considerable. The rotor insulation must be designed and applied so as to withstand these forces when in service.

Radial slots are machined in the rotor body to take the field windings. Molded mica cells, made several inches longer than the slots, insulate the coils from the rotor body, and in certain cases where ventilating ducts are provided in the rotor the mica cell is fitted inside a thin steel cell which in turn fits in the rotor slot. The steel cell protects the mica cell where it crosses the ventilating ducts.

Putting the Winding on the Rotor

The rotor coils are formed to shape, and mica built up on a strip of thin paper is fastened to one side of each strip with varnish before winding the coil in the slot. The rotor coils are wound one turn at a time, as shown in Fig. 3. Varnish is applied to each turn as it is laid in the slot, and a strip of mica is laid in the top of the slot when the coil is in place. When completely wound the coils are pressed with special clamping rings and the rotor undergoes several days' baking in an oven, during which the clamping rings are tightened several times. The rotor coils and insulation become practically a solid mass with this treatment.

When the baking is completed, brass strips are placed on top of the insulation in the slots and the rotor wedges are driven into grooves machined in the tips of the teeth. The parts of the coil extending beyond the rotor body are then covered with a layer of asbestos tape filled with varnish to keep dirt from collecting on the coils. The rotor coil ends are supported by steel retaining rings *S*, Fig. 4, which are lined with mica with a fishpaper facing. The insulated retaining rings are pressed on over the coil ends when the rotor winding is completed. The rotor is then given a further baking before it is finished.

A new type of rotor insulation has recently been developed for use where the conditions under which the insulation must operate are severe. A full-sized model was built which would imitate the conditions in a turbo rotor; that is, expansion and contraction of the coil, pressure on the coil ends and temperatures as high as 150 deg. C. The new insulation showed no signs of deterioration after 2,000 cycles of heating and cooling over a temperature range of 30 to 150 deg. C. and with pressure on the coil ends considerably higher than those obtained in present turbine-generator rotors. For purposes of comparison a similar test was run with the ordinary rotor insulation, which failed by abrasion after 200 cycles under the same condition of temperature and pressure.

Freedom from insulation breakdowns depends a great deal upon the attention given to cleaning and inspection of the machine by the operating company. Most large plants now make a practice of removing the generator end bells at regular intervals, at which time the stator and rotor windings are thoroughly blown out to remove any accumulations of dirt and the insulation is examined for any indication of notable sources of trouble. Such maintenance work is well worth the time and expense involved.

Obtaining the Load on an A.-C. Motor with an Ammeter

On a direct-current motor there is a fixed relation between the load on the machine and the current supplied to it, as obtained on an ammeter, provided the motor is in proper operating condition. That is, if the full-load current of the motor is 56 amperes and an ammeter indicates 28 amperes, when connected in the motor's armature circuit, it shows that the motor is carrying about 50 per cent load. With alternating-current motors no such relation exists, since the power factor varies with the load, and in the case of a synchronous motor the power factor is an adjustable quantity. Furthermore, the power factor of a given size motor will vary with the speed for which the motor is designed.

As to the effect of power factor on the current of an induction motor, take the case of a 10-hp. three-phase 440-volt slow-speed machine that at full load has a power factor of 0.80 and at half load 0.60. With full load on the motor the current is about 14 amperes, and at half load the current will be about 10 amperes. The latter would indicate that the motor was considerably over half loaded. In other words, to drive a 5-hp. load the motor requires 10 amperes, where applying 5-hp. additional load increased the current only 4 amperes.

How Thermocouples May Be Used for Estimating Heat Loss from Surfaces

By C. A. MIKETTA*

THE heat loss through a furnace wall can be estimated directly by measuring the surface temperature and referring to a chart. With the information here given, radiation need no longer be classified with the "unaccounted for" losses.

IN DETERMINING the heat balance of a furnace, boiler or any other thermal apparatus, the heat input and heat of combustion are generally balanced against the useful output and the most easily calculated losses, such as heat in exit gases, loss in ash, etc. The difference is reported as "losses unaccounted for *and radiation.*" An item obtained by difference is generally deemed inaccurate and questionable.

One of the reasons why radiation losses have not been determined on all thermal apparatus in active service is the lack of information regarding this determination. The effect of texture, density and color of the radiating surface on heat radiated therefrom has not been completely presented. Whenever the apparatus or unit is in active operation, the radiation losses may be readily determined with fair accuracy, as hereinafter described.

C. R. Darling, in *Engineering* (London), reported the total heat loss from vertical metal surfaces at various temperatures to air at 70 deg. F. His data have been used as authoritative for some time, but the details concerning the methods of testing and conditions during the test are not available.

Professor Trinks, in "Industrial Furnaces," Vol. 1, 1923, published a formula for heat losses from plane vertical rough metal surfaces in still air. Trinks' formula and Darling's experiments are plotted on the accompanying chart.

Inasmuch as most kilns, boilers, etc., have their exterior walls constructed of red or common brick, it was thought desirable to determine the total amount of heat radiated from a brick surface. The apparatus used was a modification of the high-temperature thermal conductivity apparatus developed at the laboratory of the Celite Products Company from a basic arrangement designed by Doctor Van Dusen, of the Bureau of Standards.

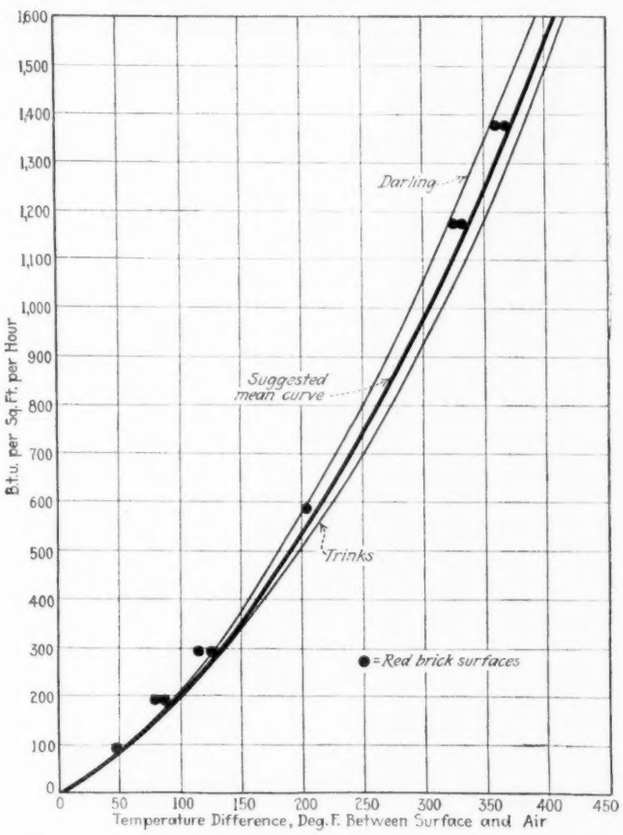
Readings were taken on a red-brick surface ground plane with a carborundum rubbing stone, a similar surface coated several times with freshly hydrated lime, and on a red brick surface brushed with several coats of lampblack in water.

The average difference obtained in surface temperatures of the red, white and black specimen for the same heat loss was only 3 per cent, which is certainly within the experimental error.

*Chemical engineer, Celite Products Co.

The values obtained for red brick are plotted on the accompanying chart along with the previously mentioned curves of Darling and Trinks. For surfaces at temperatures above 500 deg. F. this curve may not fall as closely to the theoretical figures expressed by Trinks, but it may be assumed that for large vertical surfaces color does not influence radiation of heat to any appreciable extent up to red heat (where color ceases to matter).

In view of the marked agreement among the results obtained by the various investigators, it is suggested



Curves for figuring the heat loss from brick walls or other vertical rough surfaces

that the average curve shown be used for brick, cement and unpolished metal surfaces. Polished metal surfaces show a smaller loss, but such surfaces are rarely met in practice.

Measurement of Radiation Losses

If we consider a typical boiler wall, for example, with an internal gas temperature of 2,400 deg. F., what is the amount of heat lost by radiation? The heat loss will of course depend on the structure and thickness of

the wall, but primariliy it will depend on the outside or cold-surface temperature. A wall constructed with 9 in. of firebrick and 8 in. of red brick under the foregoing condition will have an outside temperature of 380 deg. F., which is equivalent to a loss of about 1,000 B.t.u. per sq.ft. per hour, while a wall with 9 in. of firebrick, 4½ in. of insulating brick and 4 in. of red brick will have a surface temperature of 215 deg. F. corresponding to a loss of about 350 B.t.u. A reduction of 43 per cent in surface temperature results here in a 65 per cent saving in the heat lost by radiation.

This total heat loss by radiation may be determined without considering thermal-conductivity factors of the various components of the wall or the thickness of the components. No formulas are needed. Conduction of heat through the wall is the mechanism by means of which the heat is supplied to the radiating surface, but the actual heat radiated from that surface to the surrounding medium is governed by the temperature of that surface.

An actual determination of the amount of heat lost by radiation from a unit in operation may lead to plant economies resulting from a proper use of insulation in new or rebuilt units. A layer of insulating material offers larger resistance to the passage of heat through a wall and materially reduces the radiating surface temperature. A 40 per cent reduction in the surface temperature of an average industrial furnace means a 60 to 65 per cent reduction in actual heat losses.

How the Measurements Are Made

The only apparatus required to ascertain radiation losses from heated equipment consists of a millivoltmeter and several base-metal thermocouples. Thin-wire couples should be used, say 32 B.&S. gage, and the millivoltmeter should preferably be a two-scale instrument, for example, 15 to 30 millivolts.

A number of readings should be taken at various points on the surface of the apparatus being tested. The tip of the thermocouple should be inserted in a small groove made in the outer brick and held in place there with a small pat of asbestos cement. If steel incased and painted equipment is encountered, the paint should be scraped off at the point at which a reading is taken. One thermocouple should be attached to that section of the apparatus which probably varies most in temperature and maintained there during a day to determine whether the apparatus is in thermal equilibrium. Readings at other points should be taken when equilibrium conditions appear to exist.

The temperature of the air should be taken at a distance of from three feet to ten feet from the vertical walls of the apparatus. After the total radiating surface in square feet has been calculated, the accompanying chart can be used to calculate the total heat loss.

Where the apparatus has zones of high and low temperature on the surfaces, the losses should be calculated for each zone separately.

[Experts differ as to the advisability of estimating surface losses from measurements of surface temperature. It is pointed out by some that the heat loss from a given surface with given temperatures of surface and air varies considerably with small variations in other conditions, such as air velocity. Resort to this convenient method in any particular case must be determined by the user's estimate of the errors involved and the accuracy required.—Editor.]

This Plant Helps To Keep Cleveland Warm

THE Twentieth Street steam heating station of the Cleveland Electric Illuminating Company, supplying offices, stores, hotels and buildings in the downtown district of Cleveland, has been in operation for slightly more than two years.

Construction was started July 1, 1924, and the plant went into operation six months later. The present equipment of three Stirling-type boilers was put in operation at that time. Each boiler has 14,460 sq.ft. of heating surface and is capable of operating at 300 per cent of rating. Steam is supplied to the mains at 150 lb., and each boiler has a capacity of more than 120,000 lb. of steam per hour, a total of 360,000 lb. per hour for the plant.

The ultimate capacity of the plant will be twelve boilers of this size and type set singly in two rows of six boilers each.

Pulverized Fuel Used

Pulverized fuel is used, the burners being near the upper front drum and firing vertically downward. The furnaces are provided with water screens about 26 ft. below the burners. Milling equipment is installed in the basement, the exhauster taking the powdered coal thence to tanks above the burners. Air heaters or economizers are not used on this equipment. The three boilers now in use are connected to a common flue and served by a stack 308 ft. high.

The importance of the plant and the absence of any coal storage immediately adjacent to the property made it necessary to provide a reasonable storage within the plant itself. For this purpose three tracks are run into the building, having continuous unloading hoppers under each track. As the coal is unloaded, it is taken by apron conveyors to a point at one end of the building and dropped into crushers. From this point the crushed coal is elevated and distributed by means of belt conveyors to bins above the tracks. The storage space thus provided amounts to 7,000 tons and will carry the plant for three and one-half days at maximum ultimate capacity.

Steam Transmitted Through Welded Lines

The pressure of the steam leaving the plant varies with the load. During extremely cold weather unusually high steam velocities will be attained in the high-pressure feeders. The lines are approximately 4,000 ft. in length. Lines in the street are of welded construction, flanges being used only at valves and expansion joints.

Ninety per cent of the buildings in the downtown area are served by the Cleveland Electric Illuminating Co. system. Some of the buildings were designed with no provision whatever for boiler plants, and in others, where plants originally were installed the owners have dismantled them and converted the space to other purposes.

Figures show that for the year ended June, 1924, a total of over 1,500,000,000 lb. of steam was sold, while for the year ended June, 1926, after the Twentieth Street plant had been in operation a year, steam sold had increased to over 2,000,000,000 lb., or more than 35 per cent.

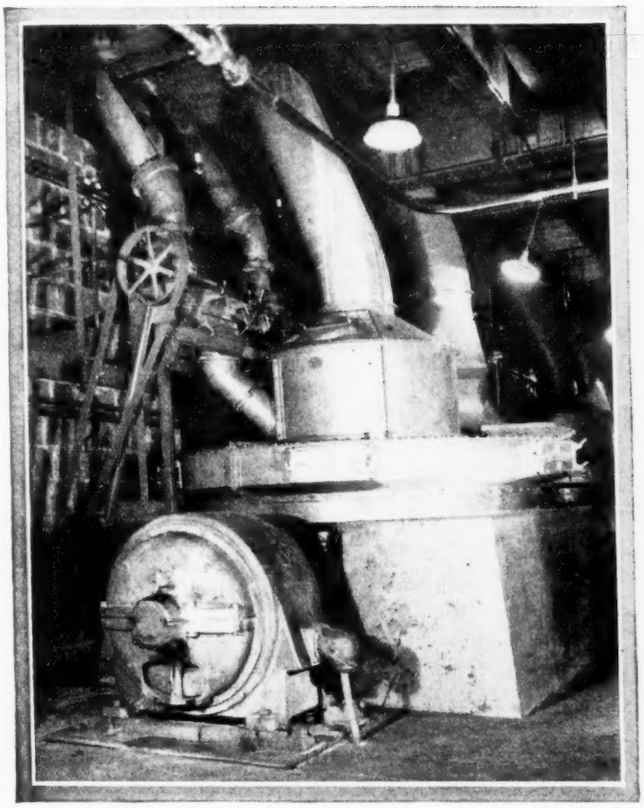


Fig. 1—Pulverizing mills in the basement

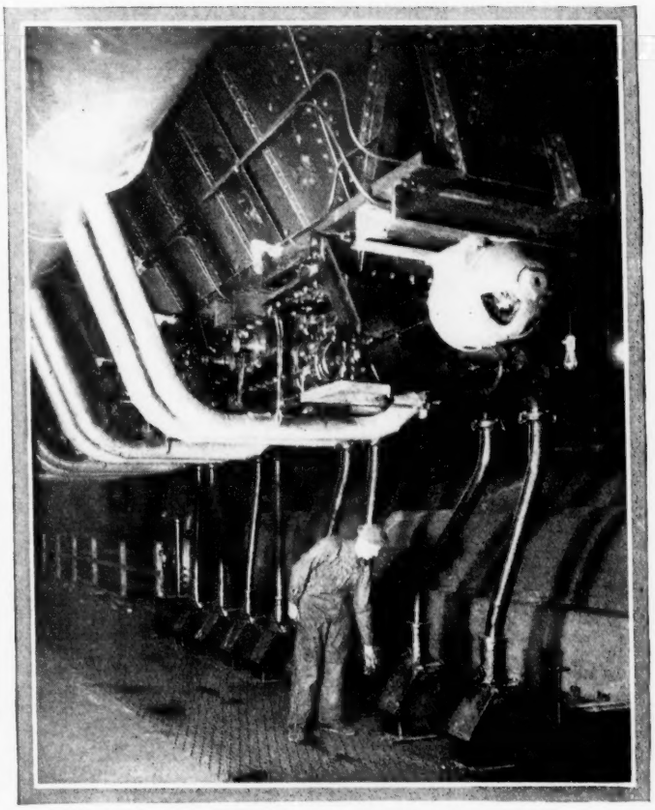


Fig. 2—Burner level of 14,460-sq.ft. boiler

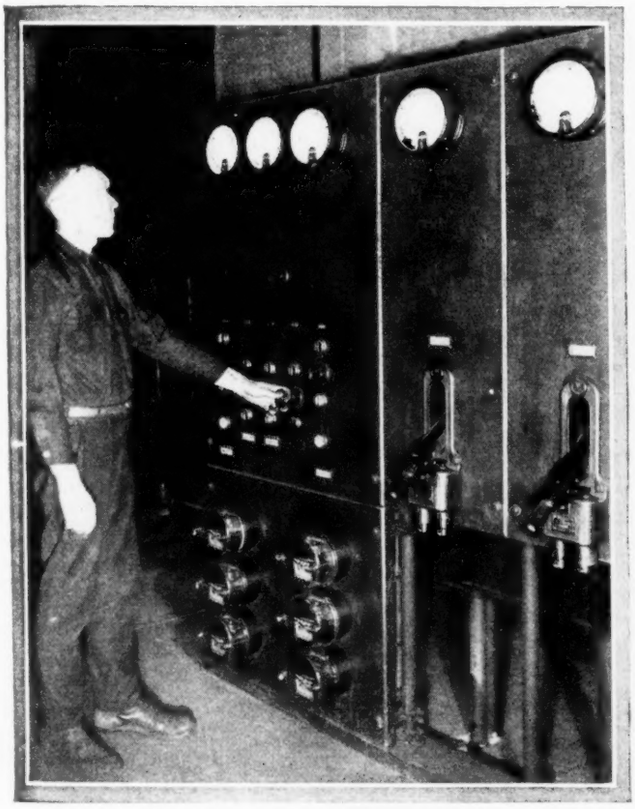


Fig. 3—Motor control board

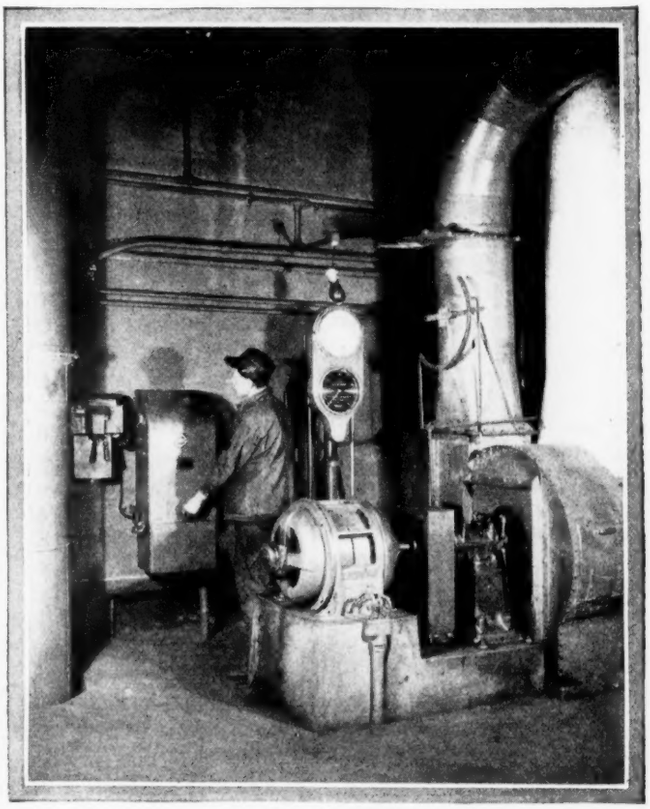


Fig. 4—Primary air fan

Increasing the Oxygen Supply Over the Fire*

BY A. E. GRUNERT

AIR drawn from main forced-blast duct and forced through a series of nozzles at the furnace front toward the center of the grate eliminates smoke and gives better combustion by supplying oxygen where there is a deficiency and by improving the air and gas mixture.

OWING to economic considerations the largest portion of the coal consumed by the Commonwealth Edison Company of Chicago for power generation comes from the Central Illinois fields. The general characteristics of the coals from these areas present serious problems from the viewpoint of efficient combustion and smoke abatement. The coal is high in moisture and ash content, has a low heat value and a low ash fusing point causes heavy slagging and clinkering. It is relatively high in volatiles and in the products of combustion has a high content of sulphuric acid. Except for the heat units it has about everything undesirable in a coal, with the inevitable tendency to smoke added for good measure.

First Attempts to Solve the Smoke Problem

Except for an experimental powdered-coal installation, the steam production of the entire system at the present time is effected by chain grates of the natural- and forced-blast types, the latter being installed in the newer installations. With the early development of the forced-blast chain grate the smoke problem gave more serious concern than with the smaller natural-draft chain grates that had been used in the past. Capacities, coal rates and temperatures were increased, and the unusually large combustion chambers provided to meet these conditions did not solve the smoke problem to the degree expected. Owing to the great width of the furnace, 24 ft., it was surmised that these conditions were due to stratification of the gases and uneven mixture of the gases with the required oxygen.

To determine accurately the actual conditions existing, careful explorations of the furnace were made, and the results embodied in Fig. 1. In a general way this chart indicates the condition of combustion in a typical, large forced-blast chain-grate furnace. It shows the composition of the gases arising from the fuel bed at the points indicated, and also the composition of the gases at the entrance to the first pass. Each one of these graphs is a composite of a large number of determinations.

The gases were sampled simultaneously at eight positions in the furnace and five at the first-pass entrance by means of water-cooled sampling tubes. These tubes were inserted through the side walls of the furnace at the relative positions shown at about 9 in. above the grate line. Each individual set of samples was collected over a period of fifteen minutes, during which time the firing conditions were held constant, so as to eliminate the effect of any variable factor in the operation, and the samplers were moved every few minutes over a distance of two feet from the center line of the stoker to the side wall and back again in order that the samples might represent the mean analysis at that position and practically eliminate the error possible by holding the sampler continuously over a spot or streak not representative of the entire fuel bed.

In the boilers it will be seen that the CO_2, the CO and the hydrogen increased over the active portion of the fuel bed and then dropped off rapidly toward the rear of the furnace. The oxygen took the opposite course, dropping to a minimum over the active portion of the fire and rising rapidly at the rear of the furnace. The excess oxygen at the rear end of the grate is due to a number of circumstances besides air getting through the fuel bed at the rear. To reduce ashpit losses to a minimum, some excess air must be allowed to flow through the last compartment. Then again, no stoker is sealed perfectly against bypass air, and it cannot be expected that any ashpit, as ordinarily con-

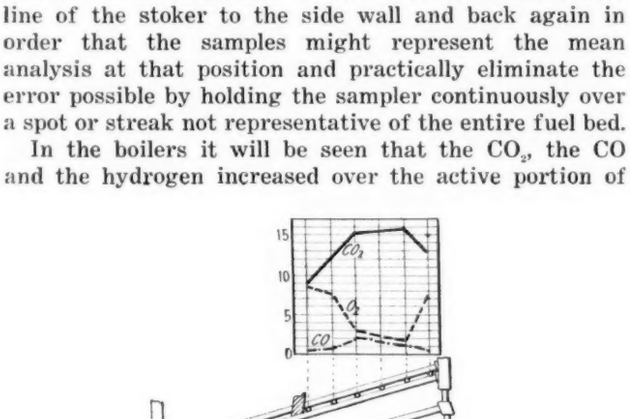


Fig. 1—Typical forced-draft chain-grate installation showing results of furnace and first-pass exploration

*From the discussion presented at a joint meeting of the Chicago Section of the American Society of Mechanical Engineers and the Western Society of Engineers.

structed, unless water sealed, will be absolutely air-tight. Therefore, there is a flow of air into the furnace which, unless properly directed, will not function to any extent in the actual combustion.

Investigation of the first pass showed that in all cases unburned gases were present and the points at which they were at a maximum were also the points where excess oxygen was at a minimum, the uneven distribution being traceable to the conditions existing at the fuel bed. The direct result of these conditions was delayed combustion, or what is ordinarily referred to as "long flaming," tipping out at a point farther on, where the unburned gases have been satisfied with the required oxygen. In these tests the usual tipping out of the flame occurred at the top of the pass and sometimes as far as the superheater.

The conditions as represented naturally suggest the means for improving them. The problem is entirely one of air distribution into the furnace above the fuel bed in such proportional amounts as required by the unburned gases present, and in addition, the introduction of this air must be such that combustion will be complete at the earliest point possible. The foregoing reference to air distribution does not mean an admission of air over and above that usually passed into the furnace, but a more logical distribution of the same amount of air or even less. In other words, air now entering the furnace as excess or ineffective must be diverted to the point where it functions in combustion. These conditions naturally suggested the introduction of over-fire air directly into the furnace in such a manner that the deficiency of oxygen not only would be supplied, but by pressure nozzle injection the desired mixture could be brought about by agitation.

Nozzle System with Booster Fan Put in Operation

Accordingly, the Venturi nozzle system with a small booster fan drawing from the main air ducts, was put into operation and tests made to ascertain to what degree the desired conditions were obtained. The nozzles for over-fire air injection were located in the ignition arch curtain wall with the center lines so pitched that the air would be directed at about the middle of the length of the stoker, this being the zone as shown by gas analyses to be deficient in oxygen. Fourteen of these nozzles evenly spaced over the width of the furnace were used, and depending upon load conditions the air was forced through them at considerable velocity at pressures ranging from 1 to 2 in. of water, the average pressure being about 1½ in. A common plenum chamber, incorporated in the arch construction, serves all nozzles, and the supply is obtained through two ducts from the main forced blast air ducts. In each of the plenum chamber ducts a small auxiliary fan serves as a booster which, in conjunction with a control damper, increases the range of pressure in the plenum box supply.

Except for minor frictional differences, the opening or closing of the plenum system does not affect the total air delivery of the main forced-blast fan. The opening of the nozzles merely diverts a portion of the same air into the furnace above the fuel bed rather than having all of it pass through the fuel bed. Having accomplished a better mixture, it is possible to reduce the main fan air delivery, as the need for so much excess air has been reduced. This naturally results in higher CO_2 and improved combustion economy.

Fig. 2 shows results in the first pass with over-fire air injection at the best pressure in the plenum box. Among the advantages derived from the use of over-fire air injection is the shortening of the flame and reduction of the final temperatures when surfaces are of the same degree of cleanliness. Combustion can be carried on with a higher CO_2 without the formation of unburned combustible gases. The slag and soot deposit in the first pass is reduced as an incidental effect of reducing the long flaming. In effectually eliminating the smoke nuisance, this system is particularly advantageous in that it offers a means of doing so with an actual increase in the combustion efficiency, whereas the usual

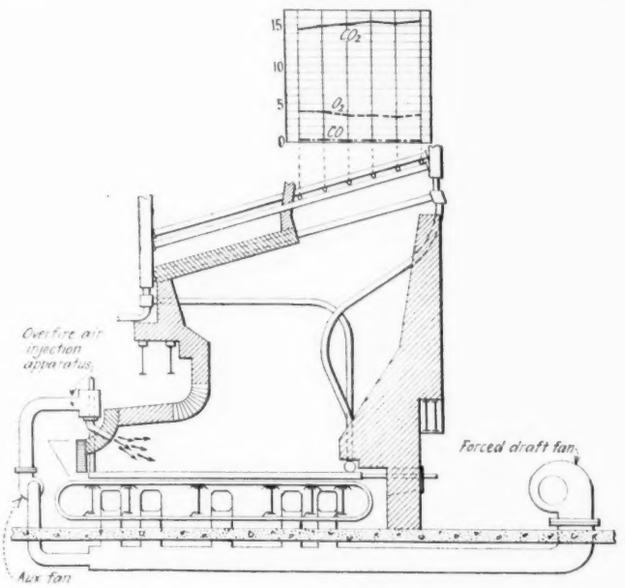


Fig. 2—Main furnace equipped for distribution of over-fire air, the first-pass chart indicating greatly improved results

weapon against smoke is excess air liberally admitted in one form or another and without much regard to distribution requirements, thus causing an actual reduction in combustion efficiency rather than the reverse.

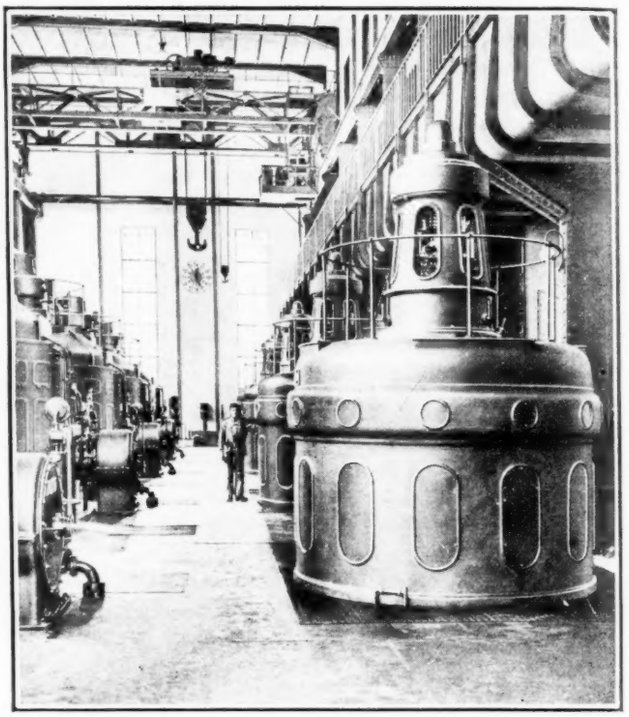
It is not expected that this means will eliminate the condition of fly ash and soot cleanings, which also may appear and be referred to as smoke. Regardless of the type of fuel-burning equipment an appreciable portion of the ash in coal is carried up the stack. Naturally, this condition is objectionable, and abatement of this nuisance eventually will be required. Development of equipment for improving this condition has been initiated, but at the present stage of the art the many devices offered seem to be far from what will be desired.

In Selecting Lubricating Oils for tube cleaners, it is necessary to consider whether air or steam is used as the motive power. A pneumatic cleaner will require a relatively light-bodied straight mineral oil of approximately 200 Saybolt viscosity at 100 deg. Where steam is used, it will be necessary to resort to a compounded steam cylinder oil. A certain amount of emulsifiable animal fat or fixed oil is necessary to give the requisite tenacity or adhesive ability to the oil film. The base of such an oil should be a steam-refined cylinder stock.—*Lubrication.*

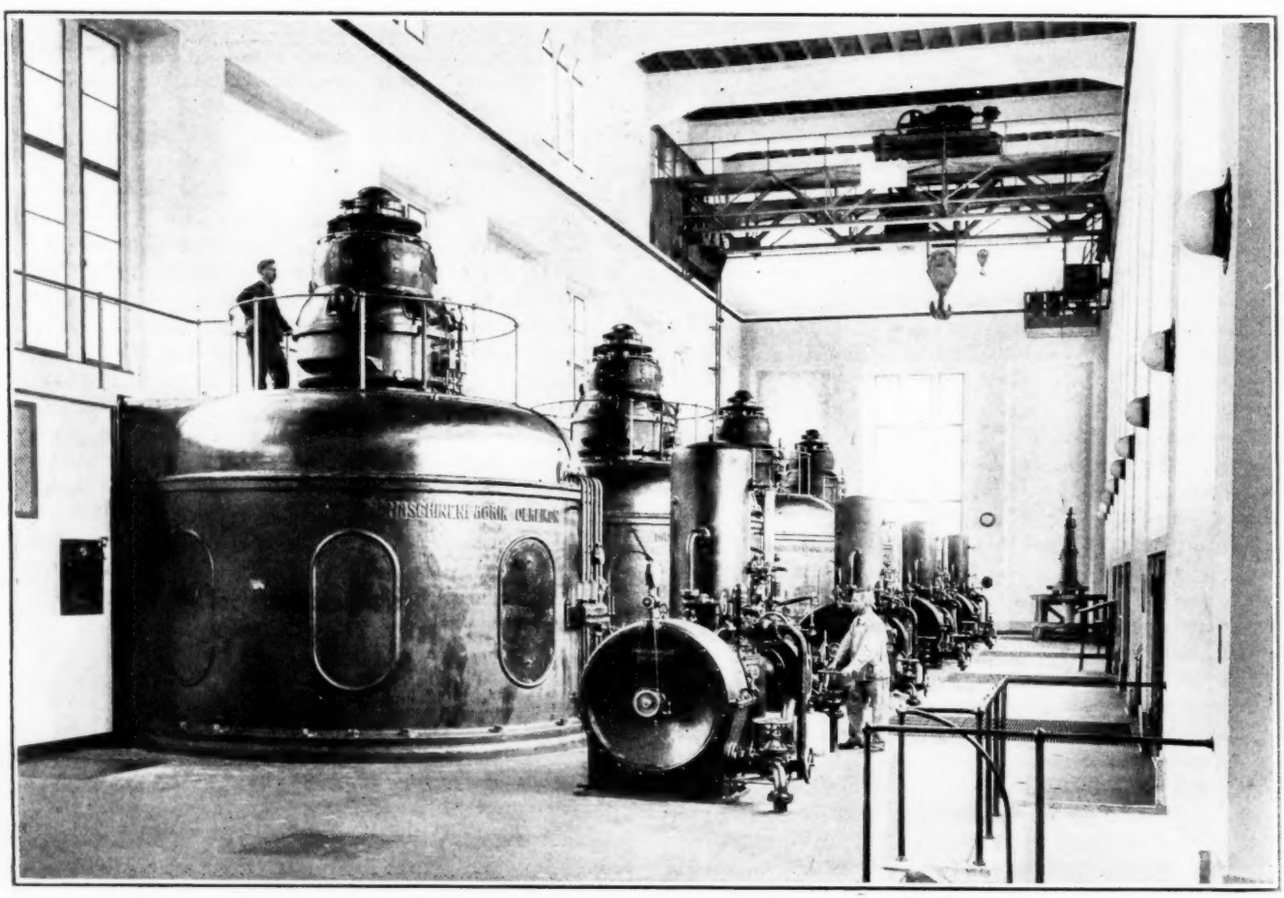
Large Hydro Project Pumps Water for Power Development

ONE of the largest hydro-electric developments in Switzerland is the Wäggital, which consists of a storage reservoir and two power plants that utilize a total head of 1,494 ft. The first plant to use the water is the Rempen, which contains four 20,000-kva. generating units and four 5,100-hp. Oerliken Manufacturing Co., 8,400-volt synchronous-induction motors driving vertical centrifugal pumps rated at 16,500 gal. per min., against a head of 850 ft. In the Siebnen plant there are four 16,500-kva. generating units.

The pumping units in the Rempen plant pump water during the summer from the tailrace of this station to the storage reservoir for power generation during the winter. As the head varies between 690 and 850 ft., according to the height of the water in the reservoir, the pump motors are built for a speed regulation of 10 per cent. The units run at a minimum speed in the spring, but as the water rises in the storage reservoir during the summer, the speed of the motors is increased; thus the pumps operate at their best efficiency and do not require throttling. In order to permit using the motors for power-factor correction when desired, the synchronous-induction type was selected. Under normal conditions they are used as variable-speed induction motors with slip regulation by means of resistance in the rotor circuit.



Rempen plant contains four 20,000-kva. generators and four 5,100-hp. pumping units, shown on the right



Siebnen power station operates under a 580-ft. head and has four 16,500-kva. units

Locating the Fault Before It Causes Trouble

By J. Elmer Housley

HEAVY slow-speed machinery involves operating troubles of a different nature from that experienced with lighter, high-speed equipment. The distinguishing feature between the two classes is the ratio of friction load to the dynamic load. In the former class, which will be considered in this article, the ratio is usually upward of 50 per cent. The equipment, when free of material in process of handling, requires an amount of power equal to between 50 and 95 per cent of the total power required when handling the full rated

MOTOR TEST RECORD

15 H.P. ALLIS CHALMERS MANUFACTURE

TYPE ... FORM ... AMP. 18.5

860 R.P.M. SERIAL No. 3K 9033.6 RECORD No. 55557 (2371)

DATE 2-15-26 LOCATION Bldg. #121 DRIVE #4 Kiln

CURRENT TRANS. RATIO 10:1 CHART FEED 12 INS. PER HOUR

V.M.	Volts	A.M.	Amps.	K.V.A.	W.M.	W.M. Corrected	KW	H.P.	P.F.	R.P.M.	CYC	REMARKS
	448	2.60	26.0	20.1		1.80	18.0	24.1	.90		30.1	
	448	2.50	25.0	19.4		1.75	17.5	23.4	.90			
	448	2.30	23.0	17.8		1.35	13.5	18.1	.76			Minimum
	448	2.90	29.0	22.4		2.20	22.0	29.5	.98			
	450	2.70	27.0	21.0		2.00	20.0	26.8	.95	861		Average
	450	2.60	26.0	20.2		1.90	19.0	25.4	.94			
						2.75	27.5	36.9				Maximum
												Kiln makes one revolution in 2 min. 20 sec.

Fig. 1—Test record of load on 15-hp. motor

amount of material. Friction is essentially a variable element and is affected by lubrication, alignment of parts, distribution of weight, speed, temperature and wear on the rubbing surfaces. It is apparent, therefore, that this class of equipment must have intelligent operating care and proper maintenance, although much of the equipment will be large and of substantial construction.

Testing Change in Friction Load

The most satisfactory gage of performance of such equipment is a motor test made at regular intervals to check any change in friction load which may indicate either the installation of a larger motor to prevent destruction of the one in operation from overload, or the rebuilding of the machine. Some of the equipment coming under this class are: Horizontal and incline conveyors of the belt, bucket, pan or apron types, grinding and some crushing equipment, coal stokers, clinker grinders and rotary cement and lime kilns.

Two tests are given which were made on a rotary cement kiln showing progressive increase in friction load. The kiln is of the familiar type of steel cylinder 8 ft. inside diameter and 150 ft. long and is rotated on trunnions by a girth gear. The kiln is prevented from creeping along the inclined axis by an almost imperceptible skew given the trunnion wheels, and in addition thrust wheels are located on either side of one of the two cast-steel box section bands which ride the trunnions and carry the weight of the kiln to the foundations. If the adjustment of the trunnions is not properly made, considerable thrust and unnecessary friction is created by the tendency of the mass of the kiln to creep one way or the other along the longitudinal axis. As the kiln revolves only about one revolution in two minutes, scored bearings on the trunnions or heavy gear shafts are not readily detected except by motor tests.

The motor-test record sheet, Fig. 1, covers a test made after the motor was reported unusually hot, and the average load was found about eight horsepower higher than the normal limit set for this drive. The equipment could not be taken out of service until about two months later, and the test, Fig. 2, shows the condition just before overhauling. To drive the load during this period, the original 15-hp. motor was replaced by a 40-hp. machine.

Graphic Wattmeter Used

A portable graphic wattmeter was used in making the tests, as in Fig. 3, and owing to the fluctuating load a chart speed of 12 in. per hour was used. For very close analysis a speed of 12 in. per min. should generally be used, but it was not necessary on this test. Two current transformers were used with a ratio of 10 to 1 on the first test and 20 to 1 on the second. The voltmeter was direct reading and a multiplier was not necessary, so that the first column V.M., in the test record sheets Fig. 1 and 2, was not used. The ammeter

MOTOR TEST RECORD

40 H.P. GENERAL ELECTRIC MANUFACTURE

TYPE ... FORM K AMP. 40

750 (25 Cyc.) R.P.M. SERIAL No. 236171 RECORD No. 55782 (1111)

DATE 4-8-26 LOCATION Bldg. #121 DRIVE #4 Kiln

CURRENT TRANS. RATIO 20: 1 CHART FEED 3 & 12 INS. PER HOUR

V.M.	Volts	A.M.	Amps.	K.V.A.	W.M.	W.M. Corrected	KW	H.P.	P.F.	R.P.M.	CYC	REMARKS
	452	1.80	36.0	28.1		1.25	25.0	33.5	.88		30	
	450	1.90	38.0	29.6		1.35	27.0	36.2	.91	874		Average
	450	1.85	37.0	28.8		1.30	26.0	34.8	.90			
	446	2.00	40.0	30.8		1.40	28.0	37.5	.91			
						2.00	40.0	53.7				Maximum
						.75	15.0	20.1				Minimum
												Kiln makes one revolution in 1 min. 14 sec.

Fig. 2—Test record of load on 40-hp. motor

was read at different loads and entered under the A.M. column. By multiplying these values by the current transformer ratio the load current given in the Amps. column was obtained. The K.V.A. was calculated by the formula:

$$Kilovolt\text{-}amperes = \frac{volts \times amperes \times 1.732}{1{,}000}$$

Taking the values given for the first test, Fig. 1,

$$Kilovolt\text{-}amperes = \frac{448 \times 26 \times 1.732}{1{,}000} = 20.1$$

The calibration curve of the wattmeter indicated that the meter was not in error more than the possible error in reading the scale, so the wattmeter scale reading was entered in the W.M. corrected column. The kilowatts were obtained by multiplying the values in the W.M. corrected column by the current transformer ratio.

The voltage of the motor circuit was applied directly to the meter, otherwise the W.M. reading would be multiplied by both the current transformer ratio and the potential transformer ratio. The values in the H.P. column are the product of Kw. × 1.34. To obtain the power factor, the actual kilowatts were divided by the apparent power. For the first test, Fig. 1, the actual power is 18 kw. and the apparent power 20.1 kva. Then the power factor is,

$$P.F. = \frac{Kw.}{Kva.} = \frac{18}{20.1} = 0.90$$

In general, the power factors given are probably a little high. This is due to the error in the meter readings being in such direction to produce these results.

A hand revolution-counter applied to the motor shaft and timed by a stop watch was used to obtain the speed

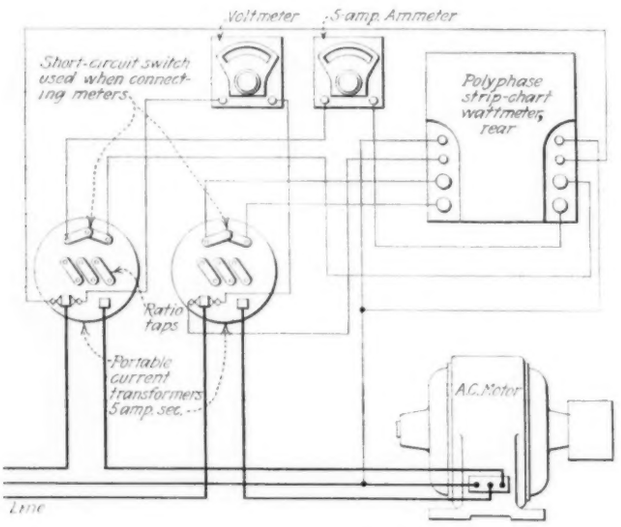


Fig. 3—Diagram of connections for making the motor tests

of the motor. The frequency was obtained from the power-house log sheet and it was uniform during each test. The kiln was marked at a convenient point and several revolutions were timed by a stop watch.

As has been previously noted, the second set of tests were made on a 40-hp. motor, which was installed temporarily in place of the 15-hp. motor that was overloaded. The 40-hp. motor was the nearest size in the reserve stock, and it had a slightly smaller pulley than was on the 15-hp. motor and gave a lower speed to the kiln.

In general, these tests only indicate the method of adapting motor tests on any heavy equipment to indicate its condition and make necessary changes or repairs in order to protect equipment and plan ahead for the maintenance jobs rather than wait for a breakdown at an inopportune time with the attendant confusion and extra costs.

AN ERROR CREPT INTO THE CAPTION of the upper illustration on page 20 of the issue of *Power* for Jan. 4. The caption states that the Westinghouse vertical pump drive turbine illustrated is equipped with an oil relay governor. This is incorrect. The governor is of the direct-acting type.

How To Make Temperature-Colored Paint

IN MANY cases one wants to know when some object is hot or cold, when a thermometer cannot be used because it costs too much, or because there isn't room for it, or because it is in an inaccessible place. Perhaps the object is a heating coil, or a bearing, or a hot or cold water tank, or the like. For such use it is easy to make up a paint that changes color with temperature.

In general, the method is to make up double iodides of copper and mercury or of silver and mercury, and mix the dry powder with spirit varnish. This sounds complicated, but is really very easy.

BLACK WHEN HOT AND RED WHEN COLD

The copper-mercury iodide is bright red at ordinary temperatures, changes to a dark chocolate brown at 160 to 175 deg. F., and to almost black at 212, but becomes bright red again on cooling. The pigment is made by mixing 1 part (by weight) of cuprous iodide with 2 parts of mercuric iodide.

RED WHEN HOT AND YELLOW WHEN COLD

The silver-mercury iodide is made by mixing 5 parts of silver iodide with 1 part of mercuric iodide. When these are first mixed, the color will be red, but it will gradually change to yellow as the mixing proceeds. The shade of color, cold and hot, can be varied by changing the proportions of the ingredients. With 5 to 1, the cold color should be a light yellow, changing with temperature to orange. With more mercuric iodide, the cold color will be a darker yellow or orange, and the hot color a brick red, at 150 to 175 deg. F.

Mixing the constituents for either of these paints can be done dry in a mortar, if the quantity is small, or in a ball mill for larger amounts. It is easier, however, to add enough distilled water to make a thin paste, and when the mixing is finished, wash the whole mixture into a shallow porcelain dish to settle. Most of the clear water can be poured off, and the balance can be evaporated over a steam bath, after which the dried cake can easily be ground to a fine powder.

The iodides required for these mixtures can be purchased from drug supply houses or can be made from materials available in any drug store. Mercuric iodide may be made from mercuric chloride (corrosive sublimate) and potassium iodide, cuprous iodide from copper sulphate and potassium iodide, silver iodide from silver nitrate and potassium iodide.[1]

The dry powdered mixtures should be mixed with a thin, light-colored, non-acid oil or spirit varnish, and applied with a brush. Metals such as tinned iron or brass may be painted with one or more coats. The paints cannot be used on aluminum, since there is a reaction with the metal that destroys the paint.

Many uses will suggest themselves to the power-plant engineer. For instance, a stripe painted vertically on a hot-water storage tank will show at a glance the hot-water level therein.

The index of *Power* for Vol. 64, the last six months of 1926, is now ready and will be mailed to readers upon request.

*Taken from an article in the *General Electric Review* for July, 1926, page 521.

[1]See the original article for more detailed instructions.

Some Words on Inventions

HARDLY a week goes by but advice is sought from members of the editorial staff concerning the merits of some invention, destined, so the promoter rosily claims, to revolutionize some industry. The chief difficulty met with in dealing with such inquiries is to explain the existence of the two phases of invention and manufacture.

It can be stated almost as an axiom that anyone can invent something; in fact, one is quite safe in saying, something workable. But the mechanical possibility of a machine is not the sole criterion by which one is to be guided when investing funds. A piece of apparatus may be in a mechanical sense above reproach, yet as a commercial proposition possess but the barest merit.

For example, new internal-combustion engine designs are being constantly evolved by inventors. Many of these engines are mechanically satisfactory and most of them will actually function. As it is the unfortunate fact that inventors generally are without any great financial means, the public is asked to invest in the revolutionary project. Statistics are presented by the promoter to show the hundreds of thousands of gasoline engines purchased yearly, and the prospective investor is invited to conclude that all this business will be secured by the new invention, although conditions may be utterly dissimilar.

One should always bear in mind the advantage possessed by an accepted make of machine. On a basis of mechanical equality the machine built by a known and established manufacturer will always receive preference. The newcomer must not only convince the public of the merits of his product, but, more important, must overcome this mental inertia.

No person should invest in a proposition until both the mechanical and the marketing possibilities have been thoroughly investigated.

Another Coal Bill Fails

IN THE face of a probable coal strike in April, if present negotiations between the operators and miners fail, Congress has again refused to consider legislation dealing with the coal industry. By turning down the Parker bill, the House Commerce Committee appears to have set itself against fact finding (one of the outstanding recommendations of the late coal commission) and granting the President authority to deal with an emergency situation, as requested in several of his messages.

Every session of Congress for the last eight years has been the recipient of proposed coal legislation, ranging from radical measures to conservative bills involving a minimum of governmental supervision. The Parker bill fell in the latter class. While it may not have been ideal and was open to some criticism as concerns methods of procedure, it nevertheless covered three important functions, namely, fact finding, mediation and emergency distribution; these to be handled respectively, by the Bureau of Mines, the President, and the Interstate Commerce Commission in conjunction with a Fuel Administrator, if conditions warranted appointment of the latter.

The much repeated slogan, "Less Government in Business and More Business in Government," is not incompatible with the ascertaining of facts and the provision of machinery for handling an emergency situation. Without the former the latter could not be intelligently applied, and the latter would be evoked only after efforts of the industry to straighten out its own difficulties had failed. However, periodic disturbances in the coal supply of the country since the War do not inspire public confidence in the industry's ability to meet such situations. Moreover, the Federal Coal Commission, after an exhaustive study by some of the best informed minds on the subject, made such recommendations in very definite language.

Is all this to count for naught? Are we to go through another period of interrupted supply with all its attendant evils? Apparently, Congress is willing, rather than take a stand against those who find it to their disadvantage to disclose facts or accept any conservative measure proposed.

The Rating of Heating Boilers

AT THE suggestion of the United States Bureau of Mines the American Society of Heating and Ventilating Engineers has appointed a Technical Advisory Committee to the Society's Committee on Research, as announced in last week's issue, to consider the subject of rating of heating boilers.

Notwithstanding their task is to fix upon a commercial unit rating, a trade term, involving no demand for scientific precision, it is not an easy one.

It may be said that the function of a boiler is to furnish steam; ergo, the rational unit in which to express its capacity is the number of pounds of water it will evaporate per unit of time.

Such a unit would be sufficiently definite within the narrow range of feed-water temperatures and working pressures comprised by heating practice, but many heating boilers do not boil. They are simply hot-water heaters. Their capacity would be measured by the amount of water that they will heat from and to a given temperature in a given time.

There might, therefore, be separate ratings for steam and hot-water boilers. Or their performances might be reduced to a common denominator in the amount of heat absorbed per hour. This involves dealing in British thermal units, a currency with which most purchasers and too many manufacturers of and dealers in boilers are unfamiliar. It is simply the unit of heat quantity, as the degree centigrade or Fahrenheit is the unit of heat intensity, and ought to be as commonly used and understood.

But even then there would have to be some specification or definition of the conditions under which the stipulated absorption took place. As against the comparatively uniform conditions under which the heating boiler operates with regard to temperature and pressure, is the extreme difference in the rates at which they are driven. The small house-heating boiler may mull along upon infrequent charges of coal put on by the householder at his comings and goings. The big heating boiler, of office and other buildings, made more important by the growing use of central-station service, may be run at express rate.

No member of the committee, it will be noticed, is identified with any of the trade aspects of the subject. On the other hand, all the members are sufficiently in touch with its practical side not to be led off into the recommendation of a unit at which the practicing engineer and the boiler manufacturer and salesman will shy, in order to invest it with the precision of the physicist.

One does not need a vernier scale to measure for a carpet.

Powdered-Coal Ash

DISPOSAL of the ash resulting from the combustion of powdered coal is presenting a problem to operators of many of the new power stations using this process. From a social viewpoint it is not desirable to discharge large quantities of this fine dust from the tops of chimneys into the atmosphere to increase its content of dirt and to reduce the amount of sunlight reaching the earth. On the other hand, it is a difficult matter to separate this fine material from the flue gases and when separated, to find some way of disposing of it economically. This dust, together with that accumulating in the bottom of the furnace, may amount to significant quantities in large plants. Many plants will have from fifty to one hundred tons of such ash to dispose of each day.

Many stoker-fired plants have been able to dispose of their ash for use as fill and as the base for roads, for making concrete and for the manufacture of cinder-blocks for building construction. The last use is increasing rapidly and is forming a profitable means of disposing of such ash.

Powdered-coal ash ranges from a sand-like material in the furnace bottom to the very fine dust separated from the flue gases. It must be placed in a fill in a wet state. On account of its fineness it may act like a quicksand when wet. When dry it will blow about the countryside. Hence it does not make a very desirable filling material when used alone.

The sand-like ash removed from the bottom of furnaces is generally thoroughly burned-out material. It is chemically inert, containing some iron oxide, and should make a satisfactory sand substitute for making concrete or other molded products.

The dust caught in the passes of the boiler often contains some unburned coke particles that make it unsuited for concrete and for certain other uses. However, this portion should prove excellent filler for fertilizer manufacturers. The fine dust from the chimney gases should be thoroughly burned-out material and might therefore find a place as a paint filler, paper filler, as a base for wall-board products and for similar purposes.

This subject has been given little thought by engineers. In fact, the whole problem of utilization of such waste products has not yet received the full attention that it deserves. It is true, however, that the thoughts of engineers are now being turned to this problem and uses will undoubtedly be found for such waste products. A full discussion of the possible utilization of powdered-coal ash will be welcomed by all who are confronted with the problem of its disposal.

Getting the Most Out of Your Meters

WHEN properly applied and used, meters have a place in the economic operation of every power plant and industrial process. In fact, it may be said that they are essential to intelligent operation. Authoritative information on the results that have been obtained by properly using meters is their best recommendation, but still there are many plants in which, outside of a pressure gage or equally essential instruments, meters are practically an unknown quantity. There are also many other plants in which they were installed during a spurt of enthusiasm, and after the novelty wore off they were allowed to go into the discard.

Meters, like almost every piece of equipment, may do a lot to help along the job, but they cannot be expected to be the whole works. The leading article in this issue throws some interesting side lights on the use of meters and what they can accomplish. The author states that "When meters are first installed, the operator feels that his work is being checked and that any subsequent suggestions are unwarranted criticism. However, with a little diplomacy and friendly co-operation, he is quite easily won over, and in a short time is using the equipment to better the results of his labors. In fact, the operator usually becomes so dependent on the equipment that he is at a loss when it is not available for his use." In that statement is a very large part of the story of the successful use of meters. The operator must be won over to have confidence in them and the use to which the story they tell will be put. He must be taught how to use them intelligently to make his job better and his work easier. Until this is done, those responsible for their installation are not going to be very successful in getting results.

Meters are generally looked upon as a means of improving the efficiency of a plant's operation or of producing a better product and in this way making a saving that will warrant the cost of their installation. As shown in the article referred to, the steam-flow meters have, along with other factors, been responsible for a large saving in investment in new boilers, that must have been made if the plant's operation had continued as before the meters were installed. The meters have not only made a material improvement in the plant's efficiency possible, but also a large increase in its capacity.

What is true of steam-flow meters in the boiler plant and on the process-steam lines, is also true of other classes of instruments when intelligently applied to the service for which they are designed. Although they are valuable as watch dogs on the plant's operation and are constantly alert, they must have the co-operation of the human element, or the information made available by them will be useless.

Ideas From Practical Men

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Why the Chief Was Fired

Recently, the chief engineer of a large power plant was discharged by one of the head executives, who went over the head of the superintendent. The superintendent, incidentally, was the one who had engaged the deposed engineer. There is special significance in that the chief was a comparatively young man. He had aptitude along certain lines and appealed agreeably, from the superintendent's point of view. However, apparently there was something out of joint, probably because he had been in charge of a staff comprising mostly older men.

Naturally, there will always be some contending that young engineers make better executives than the older, which is true enough under some conditions. On the other hand, those in highest authority in the power plant will oftentimes have nothing to do with the young engineer, particularly when they have been relying on the veterans for such a long time. Those in charge hold that they have been receiving satisfactory results from the old-timers and that they do not care to experiment.

Whether the chief engineer obtains desired co-operation from his staff depends in large measure on the way he understands the individual men. In the case where the young chief was fired, the higher executives believed that he could not work amicably with men much older than himself, there being some on the staff twice his age. The young chief was a forceful character, perhaps a little more so than his older subordinates wished, and with him it was often largely a question of speed. His decisions were quick; he did not dilly-dally. Some on the staff said he was conscientious and energetic, but truly lacked the experience that only comes with time.

The dismissal, of course, was inspired by inharmony, an element which causes inefficiency in many a power plant. But now consider the sequel. Whether the superintendent was pleased or displeased, the successor was chosen by the same individual who had sponsored the discharge. And the super was given to understand that henceforth no young engineer was to be selected as chief, and in all other instances the more experienced engineer was to be preferred.

The new chief was not picked from the staff. He came from a distant city, was a hearty old-timer, and he knew his business. Right away he started in to become acquainted with his assistants. He talked to each man, individually, so he could get each man's attitude toward him and the plant. How many power plants would not benefit by similar procedure!

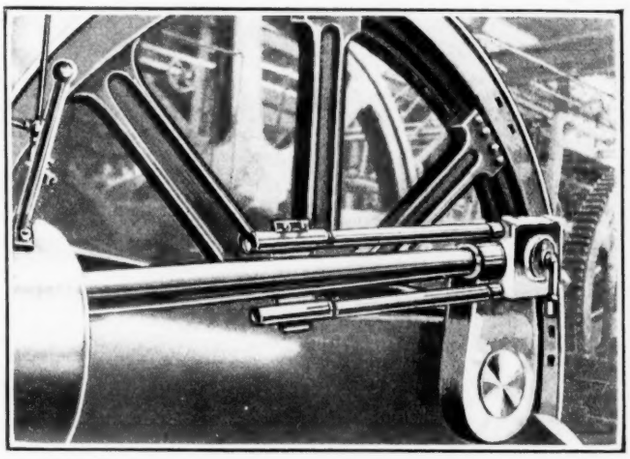
Needless to say, the new chief did not come amiss, because he let it be known from the start that he was with the men and that he expected whole-hearted co-operation from all. Being nearer to his own age, he probably could better understand them; and furthermore the older engineers prefer to work for one of about their own age. Many times the old experienced engineer resents orders from a comparative newcomer. Having been an engineer for a goodly number of years he naturally believes he knows more.

Brooklyn, N. Y. FRANK V. FAULHABER.

A Connecting-Rod Repair

It occurred to me that the method we used in repairing a broken connecting rod of a 26x48-in. horizontal piston-valve engine might be of interest to other readers.

When the rod broke, the piston and cylinder cover were also smashed, but we were fortunate enough to get second-hand parts to replace these two members. As no spare connecting rod was on hand, we were compelled to make a temporary repair until a new one could be obtained. The break occurred at the crank end of the rod due to a flaw in the metal at that part.



How the rod was repaired

The repair decided upon was to shrink a collar on after suitably machining the rod at the point of fracture. The collar was machined all over and bored out at both ends 0.004 in. smaller than the turned portions on the rod. A distance piece integral with the collar was left over the middle to make up for the metal machined off the faces of the break. After the collar was heated to a red heat, it was shrunk on. The original crank-end bolts were scrapped, and two were made with an extension leading back from the head of the bolt to a suitable place near the middle of the rod. Cotter-ways were cut through the ends of these bolts and through the rod, to take a cotter, which was inserted and securely fitted. Sufficient space was left at the bolt head to allow for draw when the nuts were tightened. The rod was put back into commission and worked without the slightest trouble for two months, when we received a new one. RONALD SIMMONS.

Antigua, B. W. I.

Metallic Packing Has Long Life

There is a set of metallic packing on the piston rod of a hoisting engine at No. 3 mine of the Spring Valley Coal Co., Spring Valley, Ill., that had been in use 12 years last August.

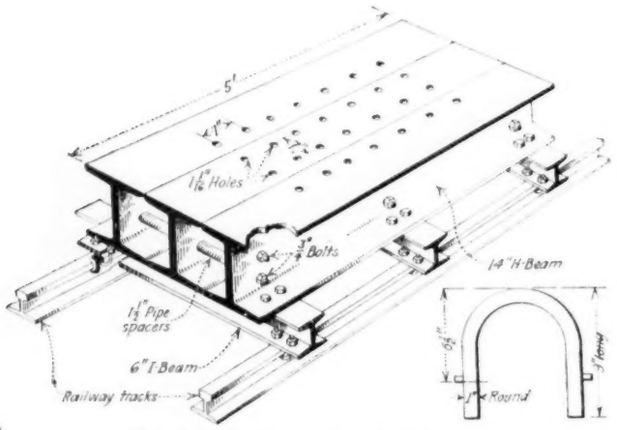
The case for the packing is home-made. The stroke of engine is 42 in. and the pressure is 100 lb. gage. The engine will average about 500 trips per day at 20 revolutions per trip, which means that the rod travels approximately 21,000,000 ft. per year. The rod is 3⅞ in. in diameter and is as smooth as glass.

How is this for a record for metallic packing?

Spring Valley, Ill. A. H. HALLADAY.

A Bending Table for Power Plants

Bending pipe and other materials is a common job around most power plants. In one case where there was a lot of this work to do, a bending table, shown in the figure, was made from H-beams that happened to be available. As can be seen from the figure, this table consists of three 14x14-in. H-beams, bolted to



Bending table made of H-beams

three 6-in. I-beams, which are in turn fastened to the railway track running into the plant. In the top of the table are drilled twenty-eight 1⅛-in. holes into which are inserted U-bolts, which may be shifted about the surface of the table at will to suit the bend being made.

There are four bolts, which are made of one-inch round iron and each one has a small projection welded on it so that it will extend about 6½ in. above the surface of the table. The U-bolts are used instead of straight bolts to give rigidity and to prevent enlarging the holes in the top of the table. In bending the pipe is heated at the point where it is desired to make the bend and then placed between the pins and pulled by hand until the proper radius is obtained. On a 4-in. pipe about five heats are necessary to make a 24-in. radius right-angle bend.

Boiler plate up to ½ in. thick has also been bent by heating it at the desired location and fastening it to the table with C-clamps. A flatter was then placed on the plate where the bend was to be made and the flatter struck with a sledgehammer. By this method the plate is not hammer marked. The table has also been found useful for laying out sheet metal or structural steelwork. In fact, it is surprising how many uses one finds for such a table around a plant.

Holtwood, Pa. C. HENRY ENGLEHART.

Boiler Experiences in Cuba

In the summer of 1923 I took the position as assistant engineer of one of the big sugar centrals in Cuba, and being given the care of the boilers, I proceeded to get them into shape for the crop season. There were 13 boilers, seven 2,500-sq.ft. return-tubular and six water-tube of the same size.

All the handhole plates had been taken off of the water-tube boilers, which I was told had been leaking badly. Upon examining the seats of the headers, I found that they had eroded badly from the action of the water leaking between the cap and the seat. All the caps had to be refaced in the lathe to get them true, and the seats had to be ground and scraped to a good fit. Many of the seats had to be built up by electric welding, then ground and scraped to a good surface. The tubes were covered with burnt carbon and considerable cylinder oil. We first tried brushing these, but finally had to turbine them.

The tubes in the fire-tube boilers were covered with a soft scale that could not be removed with the tube hammer, so we tried kerosene, using ten gallons in each boiler. The oil was spread on the tubes, left to stand several days, then the boilers were filled with water to the steaming level and with a light fire boiled for four days, then seven buckets of soda ash were placed in each boiler and boiled again for four days. At the end of this time several wheelbarrow loads of scale were removed from each boiler.

Mention should be made here of the great quantity of cylinder oil that was found in the boilers and the method of eliminating it. There were grease extractors on the exhaust lines, but these did not remove all the cylinder oil from the steam, so we designed a filter for use in the feed-water line, using loofa sponges as the filtering medium, but the sponges did not stand up well under the pressure, which was about 8 lb. gage. The filter was made from a flanged section of cast-iron pipe 42 in. in diameter and 10 ft. long. This was fitted with heads cut from sheet steel plate and reinforced with angle iron. A sheet-iron diaphragm or partition perforated at one end was placed in the center lengthwise of the pipe. The water entered on the top of this partition, flowed to the far end, then down through the perforated section and back to the inlet end. Sponges were placed above and below this partition, about 1,200 in all being used. The filter proved satisfactory, the only objection to it being the cost of the filtering material.

After the first year, owing to the improved condition of the boilers, we had so much bagasse that the men detailed to handle it could not dispose of it fast enough, with the result that we built a steam ejector for removing it from the conveyor to the storage.

I should mention here that the boiler feed is made up of the return water from the evaporating apparatus, some pure water and condensation from the exhaust from the several engines around the central. During the busy season we have samples of the water in each boiler taken at least once a day, and these samples are analyzed daily to determine if any acid is coming over from the evaporators or vacuum pans and whether the water is acid or alkaline, and to know about the treatment or the amount to blow down.

To sum up, the cause for the poor conditions of all boilers that I have come in contact with is negligence.

Manati, Cuba. E. C. BLISS.

Comments from Readers

Estimating the Blowdown

Referring to the comments of M. M. Gooch in the Dec. 7, 1926, issue regarding the article by J. D. Jenkins in the Oct. 26, 1926, issue on estimating the blowdown, I cannot agree with Mr. Jenkins that the steam pressure has any appreciable affect on the water level in a boiler other than that caused by volumetric expansion and contraction of the water due to the temperature changes, which under operating pressure fluctuations would be too slight to be observed in the water glass.

The factor that would cause the most serious error in estimating the blowdown would be the change in water level due to load changes on the boiler during the blowdown period, rather than changes in pressure.

Kalamazoo, Mich. C. BARRY.

Welded Boiler Drums

An editorial in the issue of Dec. 28, 1926, referred to a suggestion made by me at a recent meeting of the A.S.M.E. in connection with the report on "Embrittlement of Metals." The following paragraphs outline in somewhat greater detail my ideas on this subject, which I believe merits more attention than it has received to date.

Boiler drums are rolled cold into cylindrical shape, and in so doing the metal is severely cold worked. As a result of this, in its finished circular form, the metal must be under high internal stress. Riveted joints never have the full strength of the original plate, for some of the metal in the cross-section is removed when the rivet holes are drilled. When rivets are driven further internal stress is introduced in the metal plate of the drum by the pressure of the riveter and also by the stresses set up by the shrinkage of the cooling rivet. The rivets themselves are also under internal stress due to the same causes. Further stresses are often induced in the plates by the process of calking the joints for tightness. These considerations indicate that riveted joints are less strong than the boiler plate itself. There are no means of determining the amount of these internal stresses. Hence the total stress on the metal is not known.

Recent research has indicated that high stress is a contributing factor in promoting failure by embrittlement, especially when boiler-feed waters are high in bicarbonate of soda and low in sodium sulphate. In fact, Professor Parr's work indicates that this stress exceeds the elastic limit of the metal when embrittlement occurs. One step in the solution of this troublesome cause of failure would therefore seem to be the development of a boiler drum in which high stress, both external and internal, would be greatly reduced or practically eliminated.

Hammer-welded joints have been extensively used for many purposes in this country, such as in high-pressure steam manifolds and piping. This form of weld has been used for many years in Germany on boiler drums by Borsig and others, and it should be possible to get considerable data on its operating performance in that country.

Some engineers do not favor the hammer weld, as it is difficult to maintain large sheets, such as are used in boiler drums, at a welding heat during the full time required for the operation. Furthermore, it is sometimes difficult to test such welds carefully or to stop any small leaks that may occur in the joint.

Oxyacetylene welds have been used successfully on high-pressure piping, and these have proved satisfactory after years of use.

The development of welding by atomic hydrogen offers a hopeful solution to the problem. No oxides are formed in the joint with this system of welding, and a strong homogeneous weld can be made which may be built up to any desired thickness. Like all methods of welding where the metal is brought to a liquid state, the material on either side of the weld becomes highly heated and grain growth proceeds. Two strips of metal are thus formed on opposite sides of the weld with coarse crystals, which are weaker and more brittle than the remainder of the sheet and, furthermore, having different electrochemical potentials to the other parts of the sheet, may induce corrosion. These undesirable grain structures can be corrected by proper annealing. It is therefore proposed to complete the drum by welding all joints, including any nipples for steam outlets, and the heads.

The completed drum could then be placed in a large furnace and carefully annealed at the proper temperature to produce the desired grain refinement. This will remove the effects of cold work in bending the sheets and thereby relieve the internal stresses, and will refine the grain both in the weld and in the overheated parts adjacent to it. The drum will thus be in a homogeneous unstressed condition which should be ideal for boiler service. In fact, it might be given further heat treatment and toughened if so desired.

The advocates of welding claim that it can be done quicker and cheaper than riveting. If such is the case, this saving will partly offset the expense of annealing. The present A.S.M.E. Boiler Code does not provide for such construction, but if it can be demonstrated that welded drums have the superior properties claimed for them, the code could be modified to permit their use. It would not seem necessary to use excessively high pressures to test these welds. Probably more thought should be given to the hammer test to be applied at the same time as the test pressure.

In offering this suggestion that welds be used in place of riveted joints, the writer recognizes that there may be some difficulties connected with such adoption. The extensive use of welding for high-pressure piping encourages one to believe that similarly successful experience will result from its application to the construction of boiler drums.

A. G. CHRISTIE,
Professor of Mechanical Engineering,
Baltimore, Md. Johns Hopkins University.

Because "It Is Done"

The "Foreword" in the Dec. 28, 1926, issue, "Because It Is Done," was read with interest.

The last paragraph asks a question that in my opinion is answered best by saying that the most of the human race are imitators and simply follow the example of what they see others do. It has been a theory of mine for years that only one man in a thousand really thinks; the others think that they think, that is all. If we could get the leaders of the people—by this I mean the statesmen, governors, society leaders and the "idle rich"—to cut out all of this so-called "sporting life," the "lower five" would follow suit, but they do certain things because they think they are in that manner showing the world that they are of "the upper ten."

Jones buys an automobile, not that he can afford it, but because he wants to keep up with his neighbor. Brown sees Jones buy one and he gets one too, so that he can be even with Jones. Smith goes in and buys a 25c. cigar because he sees the Judge smoking one and he wants to make the people think he is as great a man as the Judge, and so the vicious circle goes.

If the "big people" would set the example, the "little fellows" would fall in line simply to be "like them." If the desirable practices were taken up by the leaders, all others would follow, as in all things the head rules, and the head of society, the leaders, could make the change over night if they would make it the "fashion."

Wilkes-Barre, Pa. THOMAS M. STREET.

Improved Methods of Baffling Inclined-Tube Boilers

During the last year a decided improvement in the baffling of inclined-tube boilers has been brought about by boiler engineers.

It is well known by most engineers that horizontal water-tube boilers were greatly improved during the last few years by a revolution in baffling. But it is not so well known that inclined-tube boilers can also be bettered by changing to a more modern method of baffling. Advances are constantly being made in all directions, and the operating engineers should strive to keep pace with these advances.

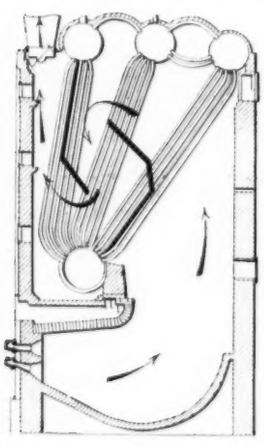


Fig. 1—Modern method of baffling a Stirling-type boiler

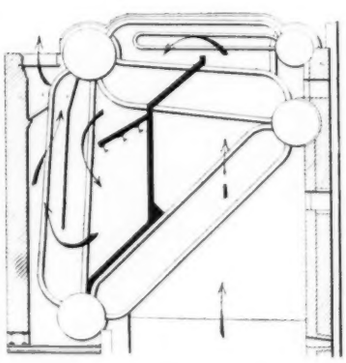


Fig. 2—Baffle gives cross-flow of gases over tube banks

Building of furnaces, boiler walls and the boilers themselves, has developed into somewhat of a science and so has the designing and building of baffle walls.

The modern method is to cut through the various banks at any angle that may be most advantageous to highest efficiency. In the old days baffles simply followed the tubes and did not cut through, particularly in the inclined-tube types.

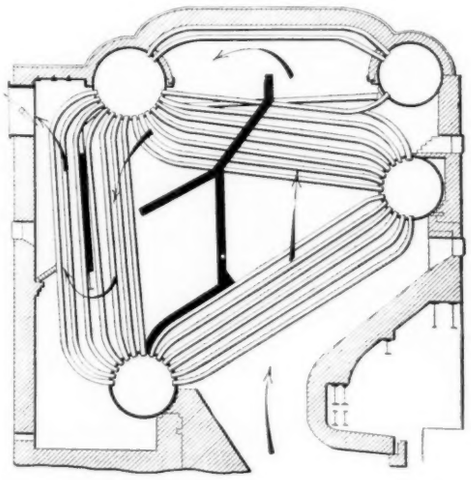


Fig. 3—Method of baffling a stoker-fired boiler

Modern methods make use of reinforcing rods and plastic fire-resisting materials, and as a result baffles are being built out in the open spaces in positions and at angles considered impossible a few years ago.

An actual instance was recently brought to my attention where, in a vertical boiler, the changing of the baffling brought about the saving of 7 per cent of the fuel, and increased the CO_2 to about 12 per cent.

The accompanying drawings show actual installations in which the baffling has been improved. Each boiler is of different manufacture and design.

The object in baffling inclined-tube boilers in this manner is to present maximum area to the fire for the absorption of radiant heat and to maintain as nearly as possible a constant gas velocity and to give a cross-flow of gases over the tubes.

Personally, I am opposed to monolithic baffles in horizontal water-tube boilers. The principal objection to monolithic construction is that it is more or less inflexible. If proper provision is not made for expansion and contraction, cracking is inevitable. Therefore there should be flexible joints in boiler baffles. At the same time these joints must not only be sliding joints, but they must be gas-tight. W. F. SCHAPHORST.

Newark, N. J.

Effect of a Water-Cooled Wall on a Wood-Burning Furnace

The effect that water-cooled walls have on a furnace burning wood refuse and other fuels, recently has greatly surprised men who operate this type of equipment.

The plant referred to contains a number of inclined-tube boilers containing from 13 to 15,000 sq.ft. of heating surface and equipped with furnaces having a volume of approximately 14,000 cu.ft. The furnaces are of the air-cooled hollow wall type of construction and were designed primarily to burn pulverized coal. How-

ever, owing to change of conditions wood refuse and other waste materials have become the main fuels and coal is used only as a standby or emergency fuel.

The wood refuse consists of the following grades: Kiln-dried shavings, sawdust, hog fuel, fuel run through shredders, bark, and in fact everything that it is possible to obtain from wood. The average moisture content of the fuel runs around 8 to 10 per cent, depending entirely on the capacity at which different departments of the plant are operating. However, on week ends a condition exists where the fuel used runs about 50 per cent hog fuel and 50 per cent shavings with a moisture content of 30 to 45 per cent.

At one time, it was thought that only a small amount of this material could be burned in suspension, therefore sufficient grate surface was provided to obtain 200 per cent boiler rating by burning all wood. The depth of the furnace was approximately 42 ft. from the flat suspended arch to the grates.

This grate surface was found not necessary as at least 50 per cent of the fuel was burned in suspension and the bare grates were found to be a detriment rather than an advantage, so the area was cut down. We discovered, after considerable experimenting, that the more this grate area was cut down the higher the percentage of wood burned in suspension and the higher moisture fuels could be burned with success, so that at the present time 100 sq.ft. of grate surface is provided at the bottom, which is considerably more than is necessary. It has been found necessary to divide the section below the grates into four compartments, thereby preventing excess air coming through the portion of the uncovered grates by being able to control the air with the ashpit doors.

Past experience has proved that although the furnaces were designed to operate at 300 per cent rating on coal and 200 per cent on wood refuse, on the wood rating the furnace maintenance costs were excessive; in fact, a complete furnace was necessary every 4 months, so the advisability of installing a water wall was considered. From the past experience it was necessary to go cautiously in deciding which type of wall was to be considered and also to how much cooling surface should be installed and still be able to burn the poorest grade of wood refuse in suspension. Therefore a water wall was decided upon which would cool only that portion of the furnace sections which burned out first.

On the one boiler that was equipped with water walls, we have obtained the following results: Over 300 per cent ratings continuously are being obtained by burning wood of the quality previously mentioned containing 35 to 40 per cent moisture without the least difficulty or slag trouble. The furnace at the bottom is absolutely clean and requires practically no attention, and there is no trouble whatsoever with smoke when running 300 per cent rating or over. This performance of course refers to burning wood refuse alone.

The great surprise was that instead of fearing that the installation of too much cooling surface put the fire out or the fuel would burn on the grates, exactly the reverse has taken place, and it is safe to say, from our experience in this particular case, that there should be no cause to hesitate in installing an entire water-cooled wall.

In this case it has been a mystery why all wood should now burn in suspension where previously not more than 75 per cent of 10 per cent moist wood would burn satisfactorily in suspension and that wood of 40 per cent moisture will all burn in a furnace of exactly the same design, but having two-thirds of the wall surface water cooled.

The foregoing should prove of interest to other operating men confronted with somewhat similar conditions, who find difficulty burning wood in suspension at high ratings with excessive maintenance costs.

Battle Creek, Mich. A. D. WILSEY.

Keeping Worn Equipment in Service

I was called into a hotel power plant by an engineer who was having much trouble maintaining the elevator service. A holiday crowd overtaxed the capacity of the passenger elevators just at a time when it seemed imperative that one must be shut down in order to pack the plunger, which leaked badly, the gland being set all the way down. I called there at 10:30 p.m. and was told that the demand for elevator service would not lessen for nearly three hours. The plunger was leaking so badly that when the operator stopped the car at the floor level, it at once slipped downward, and to hold it at a standstill long enough to permit entering and leaving, the controller had to be moved partly to the up-starting position. This resulted in a constant see-sawing which several guests reported to the manager, who commanded the engineer to do something to overcome the trouble, but under no circumstances to shut the elevator down to pack the leaky plunger.

The main valve was hydraulically operated and had a drip on each side, which suggested the solution of the problem. Since a certain pressure was required to hold the car stationary and the leak caused a reduction of this pressure as soon as the main valve closed, we concluded that if a quantity of water equal to the quantity leaking at the packing gland was admitted, the pressure would be nearly constant and the car would not drop when the main valve closed. By connecting the two drips and plugging the outlet to the sewer a bypass around the main valve would be formed, and with a valve to regulate the flow we saw a way out of the difficulty. A union and nipples of the required length were found in the pipe rack, and in a few minutes the bypass was made. The engineer went up to operate the car while I adjusted the bypass valve.

The car was allowed to drift downward with the main valve closed, and I opened the bypass till the downward movement was checked. The car was then tried for upward drifting and found all right; that is, the bypassing of water around the main valve did not increase the pressure above normal sufficient to start the car upward till the controller was moved to the up position. The car worked satisfactorily from then on, and the packing in the plunger was renewed by the third shift engineer after traffic slowed down at 2 a.m.

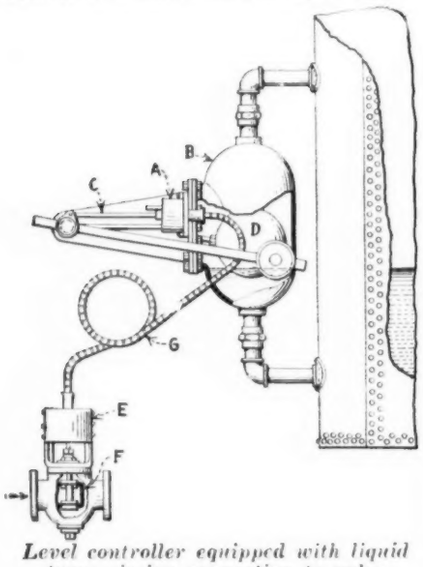
In case of leakage past the main valve when closed and a tight plunger, the opposite trouble would be encountered, the car drifting upward when the controller was in neutral. If the main valve could not be packed at once, the trouble could be alleviated by slacking the packing gland on the plunger to allow the leakage to escape. This method is wasteful of water and imposes extra duty on the elevator pump, but if makeshifts must be resorted to, it will permit keeping a car in service a few hours with a leaky main valve.

Thompsonville, Conn. G. H. HART.

New and Improved Equipment

Fisher Liquid Level Controller

The liquid level controller type 240 illustrated herewith is a recent addition to the line of controls and regulators put out by the Fisher Governor Co., Marshalltown, Iowa. The controller is fitted with a liquid transmission device so that the valve may be operated at a considerable distance away from the float cage. The transmission unit consists of a sylphon bellows *A* attached to a float cage *B*, which, by means of a connecting rod and rod crank *C* is expanded or contracted as the float *D* rises and lowers. The bellows *A* connects with a second bellows *E* on a control value *F* by means of flexible copper tubing *G*, which is filled with a liquid and hermetically sealed.



Level controller equipped with liquid transmission connection to valve

In operation with the float cage placed on the side of the tank or receiver, the change of liquid level in the tank causes float *D* to rise or fall, either expanding or contracting the bellows *A* attached to the float cage. This movement either forces the liquid from the bellows or, owing to its expansion, draws liquid from the valve bellows *E* and into the float cage bellows. This movement of the float thus causes the valve *F* to open or close as the float rises and falls.

A controller of this type is adaptable to a variety of uses including the control of the level in accumulator tanks and for use with a pump which is either pumping into or taking its discharge from a receiver. In such an installation the valve *F* is placed in the steam line, to the pump. Flexibility of the apparatus permits changing the position of the bellows on the float cage so that the valve may be made to open or close as the float rises. Also, the valve *E* may be placed at a considerable distance from the tank or adjacent to it, as best suits installation requirements.

Regulation for Excess Boiler Feed-Water Pressure

Conditions under which modern boilers operate have made the problem of feed-water control one of first importance. The reduced water-storage capacity in proportion to the size of the boiler, the high steaming rates and the wide ranges of operation have all tended toward making the control of excess feed-water pressure essential to safe boiler operation and to relieve the water-level regulator of caring for the pressure fluctuations between the boiler drum and the feed line.

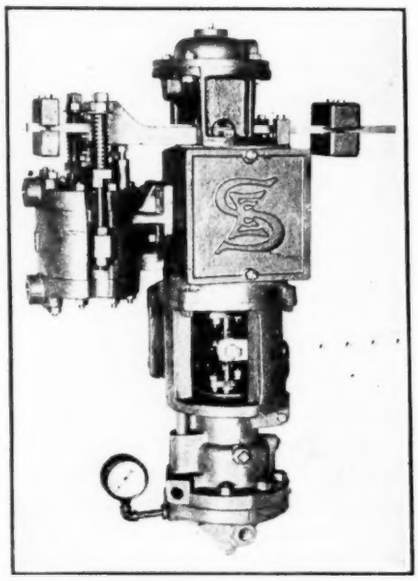


Fig. 1—Complete assembly of excess-pressure regulator

The Smoot Engineering Corp., 136 Liberty St., New York City, has recently brought out a regulator for varying the excess feed-water pressure automatically as the load on the boiler changes. This pressure should vary as the square of the boiler rating; that is, if the flow of feed water is to be doubled the excess pressure should increase four times. One way of obtaining this relation is by connecting the regulator into the gas passes of the boiler and balancing this pressure, which varies with the square of the rating, against the excess feed-water pressure. A schematic diagram of a regulator connected in this way is shown in Fig. 2 and a picture of the regulator in Fig. 1.

In Fig. 2 the first pass of the boiler is connected above the loading diaphragm *A* and the last pass below this diaphragm, which is connected by a lever to two excess-pressure diaphragms, *B*. The bottom diaphragm of the two is connected to boiler pressure and the top one to the excess-pressure side of the feed-water regulator. The arm connecting the diaphragms is connected by bell cranks and rods to the valve *C* in the pump discharge. As the lever moves up and down, this valve is opened and closed and the excess feed-water pressure varied accordingly.

Assume that the regulating system is in a state of balance. Now, if the load increases on the boiler, there will be an increase in the gas flow and an increased drop in pressure across the boiler passes. Assuming that the pressure in the first pass remains practically constant, then the pressure in the last pass will have to decrease as the square of the gas velocity. This means that the pressure below diaphragm *A* will decrease and the pressure above move the diaphragm and the right-hand end of the lever downward. The regulator being out of bal-

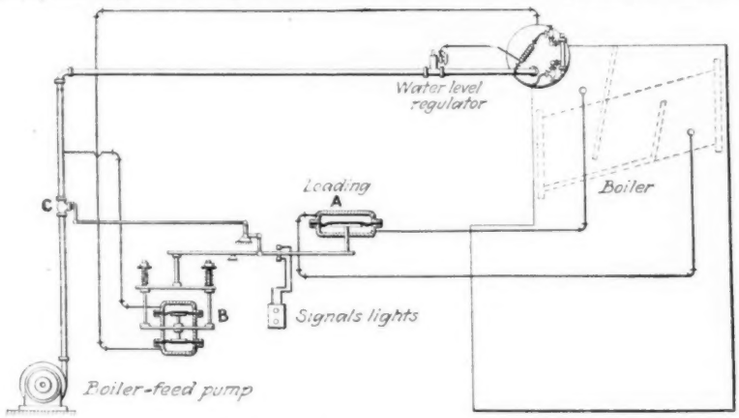


Fig. 2—Schematic diagram of excess-pressure regulator installation

ance, the excess-pressure regulator diaphragms will tend to move upward. The movement of the lever between the diaphragms is in a direction to cause the valve *C* in the feed-water line to open and increase the excess pressure. This increase in excess pressure is transmitted to the top diaphragm at *B* and will oppose the upward motion due to the regulators being out of balance. When the excess pressure has reached a value corresponding to the increased rating of the boiler, it will again put the regulator in equilibrium until there is another change in the boiler's load.

By varying the excess pressure in this manner, the feed-water regulator serves as a micrometer adjustment on the flow of water to the boiler. Boiler-feed pumps are frequently driven by constant-speed motors, in which event the excess-pressure regulation is secured by a valve in the pump discharge, as in Fig. 2. If the pump is turbine-driven, or if a variable-speed motor is used, the excess-pressure regulator will vary the speed of the turbine or motor to produce the required excess pressure.

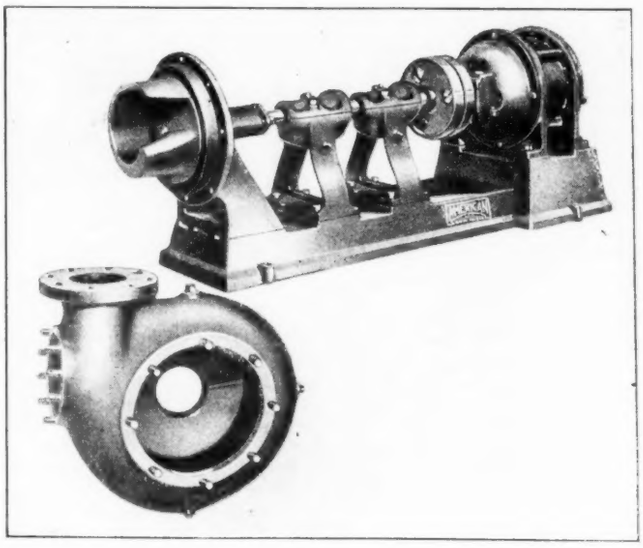
In Fig. 2 the loading diaphragm of the regulator is shown connected to the gas passes of the boiler. Where the Smoot automatic system of combustion control is used, the loading diaphragm is connected to the master regulator and the excess-pressure regulator functions in synchronism with the other parts of the control equipment.

American Non-Clogging Centrifugal Pump

The American Well Works, Aurora, Ill., has brought out a non-clogging type of centrifugal pump that is a new departure in construction and obviates the necessity of screens.

The single-blade impelled in the pump is designed so that the stream lines are not separated, but so the stream of fluid is kept in one mass and carried through the pump without being subdivided. In this way all the liquid and débris are discharged through a single peripheral passage. This precludes screening sewage or fluid containing other material before pumping.

The pump is made in both vertical and horizontal types and is particularly adapted for sewage and general industrial uses.



Non-clogging centrifugal pump

Glass Wool Insulation

The insulating properties of glass wool are little known in this country, but since the beginning of the World War it has gained in popularity in Central Europe, and several tests have proved that the finely spun threads of glass, when formed into suitable shapes, make good heat insulating material for various purposes.

According to the tests made by Prof. O. Knoblauch, of the Institute of Technology, of Munich, and from the figures given in the Bulletin of the Society of German Engineers, the coefficient of conductivity is considerably lower than that of other commercial forms of heat insulation.

Glass wool insulation is suitable for three forms of heat conductivity: By conduction, because it has low conductivity; by convection, because of its loose, flossy structure; and by radiation, because of its ability to reflect heat waves from the shiny threads of glass.

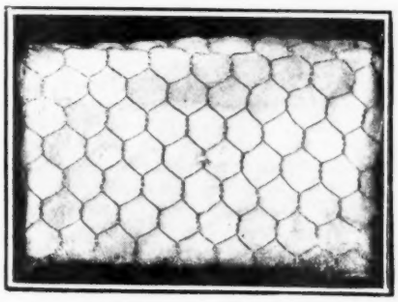


Fig. 1—Slab encased in wire mesh

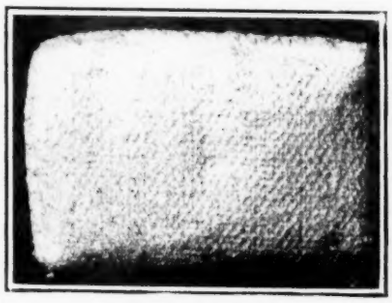


Fig. 2—Insulation wrapped in burlap

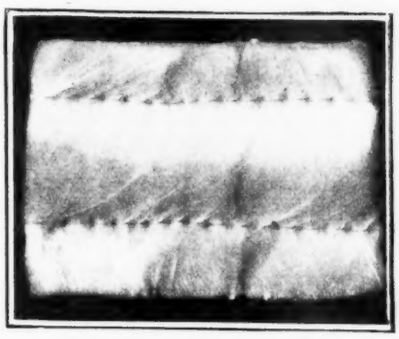


Fig. 3—Stitched slab of glass wool

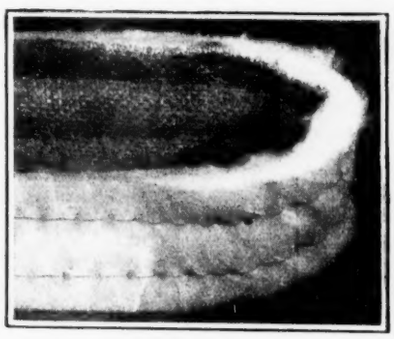


Fig. 4—Wool sewn on fireproof burlap

An important feature of this material is that even at a temperature of 1,500 deg. F. it bakes only for a layer of about one-quarter inch, the remainder of the insulation rendering effective service. Other advantages claimed for it are: It is unaffected by moisture, acid, fumes and intermittent heating and cooling; it is flexible, easily installed and withstands vibrations perfectly; it is approximately 30 per cent lighter than standard forms of heat insulation.

This material comes in loose form, as well as in slabs, encased in wire mesh, Fig. 1, or pads wrapped in burlap, Fig. 2, and for pipe insulation it is manufactured in strips, sewn on fireproof burlap, as shown in Fig. 4, requiring no other labor than winding this strip around the pipe of any diameter.

The rights for the manufacture and sale of this material in this country have been obtained by the American Engineering & Sales Corporation, New York City.

Rôle of the Civil Engineer in Power Development

AT THE Power Division session of the American Society of Civil Engineers Convention, held in the Engineering Societies Building, New York City, Jan. 19 to 21, Ira W. McConnell discussed the Rôle of the Civil Engineer in Power Development and Distribution. In presenting his paper the speaker illustrated his talk by a number of lantern slides showing foundations for power-plant structures and machines, buildings, coal-handling and storage equipment, transmission lines and other structures, all of which fall to the responsibility of the civil engineer.

"Power," said Mr. McConnell, "is peculiarly a creation and a creature of science. The idea of its existence originated in the minds of scientists, and its evolution and development rests mainly upon the efforts of those practical men of science, the engineers. The concepts of the physicist and the chemist and the financier come back finally to the engineer for a practical assembly of constituents parts which will translate an abstraction into an actual commodity which can be sold piecemeal for such a reasonable amount of cash as will justify its use.

"So we find the power station designer today selecting apparatus, such selection being mainly confined to a relatively narrow choice by the devices offered by manufacturers, and setting up an operating entity based upon and tied together by the works of the civil engineer.

"The civil engineer works in the main with such fundamentals as man-hours, cubic yards of excavation, sand, stone, gravel, lumber, cement, brick, steel, etc., etc. No manufacturer can hand him, boxed and labeled, the devices that make up the essence of his efforts. He must build from the elements, and every problem has new difficulties. Not the least of his difficulties consists in finding means by which, at a sufficiently low price to make the enterprise feasible, he can surround the space necessary to inclose the machines and devices that his brother engineers buy from manufacturers and set around in various combinations.

"A successful power station is not necessarily one that turns out kilowatt-hours dependably. I prefer to think of it as that combination of brains, capital, structures and devices which produces a needed commodity dependably at the lowest obtainable cost, taking into account and properly compensating all the factors which enter into the creation. The last word as to undertaking an enterprise usually rests with capital. The man who satisfies the inquiries of capital has to justify his enterprise in terms of income and outgo. In the final showdown he rarely has to drag the boiler room or the switching station into that final conference where the umpire says 'Go ahead.' All such items and features are details making up the complete assembly upon which the safety of the investor's money depends. My hope is that civil engineers may take a larger part in the economics and the underlying business reasons involved in power production and sale and not be confined to the smaller economics of the strictly civil-engineering features."

THE part that the civil engineer represents in power projects varies with the type of plant. Where the cost of the work in a hydro-electric project coming within the scope of the civil engineer may represent 75 per cent of the total for a steam plant, this figure is fixed at about 27 per cent.

Figures given in the paper showed that in hydro-electric developments 63 to 75 per cent of the cost of such projects is for work for which the civil engineer is responsible. In one case of a 25,000-kw. hydro-electric plant 48.1 per cent of the costs was made in the dam, forebay, canal power-house substruction and tailrace, whereas the power-plant equipment cost was only 20.6 per cent of the total. In the case of steam stations all civil-engineering features represented in the neighborhood of 27 per cent of the total cost.

It was Mr. McConnell's opinion that skilled designing of the civil-engineering features of a steam power plant may influence the final costs of the station by a greater margin than the mechanical engineer has at his disposal. Careless, incompetent or extravagant design may easily increase the cost of foundations, buildings and other purely structural elements by 20 per cent of the proper minimum. This means an equal percentage added to the fixed charges.

Discussion on the Paper

In discussing Mr. McConnell's paper, Col. P. Junkersfeld said that engineering and business sense and vision are required in conception and development of successful power projects. Take, for example, the larger problems involved in the development of steam power stations. Success for such a project requires a location advantageous for distribution of output as well as for input of raw materials, which in this case are principally fuel and condensing water. The ideal location, considering output alone, is that which permits radiation of feeders of approximately equal length in all directions, considering not only existing conditions, but future development for the sale of power. The ideal location, with respect to raw materials, calls for a site near coal mines or other source of fuel supply advantageous from the viewpoint of quality and price; also affording an ample and dependable source of condensing water.

Sites combining these requirements, each in the maximum degree, are seldom, if ever, available, and experience and judgment are required in reaching a compromise that will give the best overall result at more or less sacrifice of the minor considerations.

The man who co-ordinates these major and dependent factors for a successful whole must be broad and impartial. Such a man deals with broad engineering problems and does not necessarily bear the exclusive label of any particular branch of the engineering profession. He must be capable of effectively directing activities of specialized engineers, including the civil engineer, but he must have a balanced grasp of all the problems entering into the project. The directing head of a power project discharging these important duties may be a man of civil-engineering training as well as of training along other engineering lines, and must have initiative, ability and experience.

Some power projects, owing to their nature, offer peculiar advantages to the executive of civil-engineering training, because it is undeniable that engineering training is of great advantage to an otherwise properly qualified executive.

Mr. McConnell has presented figures which show the importance and, in some cases, predominance of specialized work involving power developments which comes under the direction of civil engineers. The accompanying table, based on recently reported costs and corresponding capacities of fifteen American steam power stations, supplements

PERCENTAGES OF INVESTMENT COSTS

	Composite All Stations Per Cent	Limits High Per Cent	Limits Low Per Cent
Land	1.0	2.6	0.1
Structures	36.0	43.9	26.0
Boiler Plant Equipment	27.9	35.4	19.4
Turbo-Generator Equipment	20.4	28.2	15.7
Electrical Equipment	13.9	18.7	9.9
Miscellaneous Equipment	0.8	3.5	0.2
Total	100		

Mr. McConnell's figures and confirms his estimate of the important rôle played by the civil engineer in the development of such projects. The stations considered in this tabulation are all of a capacity exceeding 40,000 kw., and three of them are of 200,000 kw. or greater initial capacity. They cover a wide range (1) of economic and physical conditions (2) of electrical requirements in transmission and distribution and (3) of solutions of the corresponding and progressively changing problems individually and as a complete project for dependable and economical service.

Considering the opportunities of the civil engineer in power development and distribution, it may be said that strictly engineering training and ability are not sufficient in themselves to insure success in the most responsible positions. As in other fields of endeavor, success depends largely upon the extent to which the individual grasps larger aspects of his problems and frees himself of too narrow conception of his duties. Particular study is necessary to provide a power plant suitable to the economic conditions under which it will operate, as expressed in part by the terms "load factor," "use factor" and "capacity factor." While these terms each expresses a fundamental economic condition and are of use primarily in the basic conception of the entire plant, they also have an important application to the work of the civil engineer.

George A. Orrok expressed the opinion that the power engineer must not specialize or the plant will not be a harmonious whole, and said:

"Mr. McConnell compares the work of the mechanical and electrical engineer who buys standard types of apparatus offered by the manufacturers, which material is then tied together by the works of the civil engineer, who deals with man-hours, yards of excavation, sand, stone, lumber, cement and steel, etc. This picture is what is known to the trade as 'catalog engineering,' and the product cannot compete even in price with the well designed and constructed plants which the power engineer has been putting into service ever since 1882, each succeeding plant using a little less fuel than its predecessor, turning out a few more millions of kilowatt-hours with a little more certainty at a little less cost.

"In these designs the bricks, concrete, rolled sections, boiler tubes and pipe material, the house-service switches and small motors are standard and bought off the shelf, but everything else is especially designed for that particular station. The manufacturers wail that they are not allowed to standardize, that major improvements are insisted upon with each new order. The main units in a plant are not duplicates, but increase in size and decrease in water rate as the station is filled up and our knowledge of combustion and boiler design and operation keeps pace with the increasing load demands in that locality.

"Mr. McConnell has given us some very interesting figures out of the large fund of his experience, showing that of his three examples of steam plants the portion which he terms 'civil' is roughly 26 per cent of the station prime cost. My own records of about 100 stations average 25.4 per cent. The table following shows the percentage costs at four different epochs from averages of a number of good examples.

	1900	1908	1914	1920-26
Building and Foundations..	14.5	15.5	15.0	35.5
Boiler Plant...	45.0	40.0	37.0	26.6
Turbine Plant..	35.0	39.0	40.0	22.5
Electric Plant.	6.0	5.5	8.0	15.4
	100.0	100.0	100.0	100.0

"Since 1890 the average cost of the power stations, for which I have good figures, has been around $100 per kw. Averaging the costs by ten-year periods the average in each decade has been around $100. And in the 35 years I have records of cost as low as $50 and as high as $225. It appears that the total cost of power stations over this period has been singularly constant. During this time we have reduced the coal rate from about 10 lb. per kw.-hr. in 1890 to under 1½ lb. per kw.-hr. in 1925. This last year there are at least three stations reporting a kw.-hr. on about one pound of coal. In 1890 we were content with an evaporation of about 3 lb. of water per square foot of boiler surface. Today 10 lb. is common and 20 lb. per sq.ft. of surface is, perhaps, our peak capacity. In 1890 a unit of 400 kw. was the largest machine, while today an 85,000-kw. generator is under order and 100,000-kw. generators are being contemplated. Two-shaft machines of 160,000 kw. and three-shaft machines of 210,000 kw. are under order. In 1890 our engines ran non-condensing, or at best a jet condenser was used giving vacua of 24 to 26 in., while today surface condensers with 75,000 sq.ft. of surface, giving 29 in. of vacuum are contemplated. On the electrical side generator efficiencies of 65 per cent have been increased to 97.5 per cent, while our switches, which could be safely trusted to break only a few hundred kilowatt without burning up, now have rupturing capacities of over 1,500,000 kilowatts.

"It will be noticed that despite the increase in the cost of labor (about 200 per cent since 1890) the costs of boiler plant have been reduced nearly one-half, the prime movers by about one-third, and this despite the astonishing increase in complexity which has accompanied the better economy. Electric plant has increased in cost one and one-half times, but this is due to the excessively large apparatus demanded by aggregations of power, ranging from 200,000 to 1,000,000 kw. which are now tied into one system instead of the 7,000 or 8,000 kw. of the end of the nineteenth century.

"But our column and floor loads are no heavier than they were in 1900. We do not today build three boiler floors as we did at Ninety sixth Street, nor put the boilers on the third story with the engines on the ground floor, as at Duane Street. Our building laws require no thicker walls than in 1900, and we still are allowed 20 tons on a pile when such foundations are required. To crown all, we get more kilowatts per square foot of ground and per cubic foot of building than we ever did. Yet the portion which Mr. McConnell calls 'civil' has increased about 1½ times."

A.S.M.E. and A.I.E.E. Discuss Power House Design

AT A joint meeting of the Metropolitan sections of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, held in Newark, N. J., Jan. 19, E. B. Ricketts and R. H. Tapscott described the design of the new East River Station of the New York Edison Co., and R. J. S. Pigott and W. R. Smith dealt with the mechanical and electrical features of the Kearny Station of the Public Service Electric Power Co. at South Kearny, N. J.

The East River Station is at Fourteenth Street, New York City, and on account of the restrictions in land area a number of unique problems were involved in the design and construction of the plant. These limitations made it necessary to keep the width of the plant to about 200 ft., divided 55 ft. for turbine room, 100 ft. for the boiler room and 40 ft. for the electric galleries. To accommodate the 900,000-kw. capacity, which it is expected the plant will contain when completed, it will extend about 1,000 ft. in length back from the water front. At present there are two 60,000-kw. units installed. The narrow width of the plant made it difficult to provide the necessary space for the circulating-water intakes and discharge from the condensers. This was solved by using 72-in. pipe instead of the usual type of tunnel construction. These pipes are distributed practically across the entire width of the plant with just sufficient space between them for the building columns. All the circulating water pumps are at the river end of the station and will be driven by condensing type steam turbines. It is proposed to regulate the speed of these turbines automatically to maintain a constant temperature in the discharge from the condensers. The amount of water passing through the turbine-generator air cooler is also to be automatically controlled to give a constant air temperature at the discharge from the machines, during all seasons of the year. The water used in the coolers is the same as in condensers.

All the primary auxiliaries in this plant are driven by steam turbines, and the secondary auxiliaries are driven by electric motors. Pulverized-coal firing is used, water-cooled furnace walls are installed, the combustion air is preheated and the combustion process will be regulated by a complete system of automatic control.

At the Kearny plant, which has been laid out for 370,000 kw. with one-half this capacity installed, a more conventional design has been followed than that at the East River plant. The boilers are stoker fired, and many of the innovations for the modern plant have been omitted. At the time the plant was designed, the engineers felt that a number of the refinements that were coming into use did not seem to offer sufficient improvement in efficiency to warrant their adoption. The opinion was expressed that under the present state of the art this might not be true. Experience with the operation of the plant was reported to be very gratifying and has more than met the expectations of the designers. A complete description of this plant appeared in the Aug. 28, 1926, issue of *Power*.

Increasing the Head on Turbines by Means of Excess Flow

ON MANY streams whose discharge varies between wide limits, storage on a large scale for regulation of flow is physically impossible or economically impracticable. Run-of-river developments on such streams often suffer a serious reduction in head and capacity during high flows because of the rise of tailwater. The removal of this handicap might in some cases make feasible developments that would otherwise be economically impracticable. In recent years several methods have been worked out for utilizing excess flow to increase the otherwise reduced head on the turbines or to restore approximately the normal head. Of these, the Herschel fall increaser, the Replogle discharge accelerator, the Tefft conduit spillway, the Thurlow backwater suppressor and the Moody ejector turbine have attracted the most attention.

The various devices all utilize the waste energy of the fall and passage of surplus flow in excess of that required by the wheels to eliminate or offset the loss of head ordinarily produced by the rise of backwater below the dam and to recover the consequent loss of capacity and output during high-water periods. To a certain extent they may, as in the case of the Thurlow device, under moderate amounts of excess flow actually exceed the normal low-water head. Although decrease in capacity or output from high water may be ordinarily of such short duration or of so little moment, especially in systems of interconnected plants, as to warrant no additional investment in devices of this kind, some form of special sluicing or backwater suppression may be of considerable economic value where local conditions require heavy expense in providing sluicing capacity of the usual types, or where there may be difficulty or expense in sluicing operations, or high-water losses involved requiring considerable amounts of makeup by steam or other supplemental power.

Mr. Herschel reports no data available on actual installations of the fall increaser, although the use of his device is now being considered in one case in Canada.

The only installation of the Replogle device of which there is record is one installed at the Henry Ford Farms, Dearborn, Mich., in 1915.

In the case of the Tefft spillway, which was developed for the use of the Consumers Power Co., at sites where soil bottom would make the ordinary form of sluicing difficult and expensive, a report has been received on two representative installations. The statements of results in these cases may be summarized as:

1. In comparison with the usual type of Tainter gate spillway the tube form has the advantages of considerable economy in construction; an increase in effective head by reduction of tailwater elevation brought about by the thin sheet of water rushing through beneath the draft tubes, lowering the effective tailwater elevation and producing a standing wave immediately below the power house; ease of operation from generator room without additional man power and without the usual difficulties with ice, rubbish, etc.; and the elimination of a fixed spillway crest with consequent freedom to manipulate the pond to advantage.

THERE are many power sites where the output of the plant is greatly reduced during periods of high water, and in some cases the plant is put out of service owing to high tailwater. At this time when the development of run-of-river plants is rendered economically difficult by the increased efficiency of steam-electric plants, it was considered by the National Electric Light Association's Hydraulic Power Committee, that a compilation of authoritative data regarding the several means of increasing head by utilizing excess stream flow would be of special value, and this committee has recently made a report of its investigations, of which this article is an abstract.

2. The cost of spillway tube construction will vary with each type of installation, depending upon the detail design of the power-house substructure, the spilling capacity, the head at the plant, the type of gates or valves used in shutting off the water from the tubes and the operating equipment for the gates or valves themselves. To state definitely what such an installation would cost is therefore impossible. It has been found, however, that in studies of individual plant design in each case the cost of the power house with self-contained sluices or spillway tubes is considerably lower than that of the power house and a separate spillway structure.

3. As to physical and economic results, the claims are: Better construction methods and power-house design, permitting safer construction on poor foundations and assisting the turning of the river during construction; increase in effective head during high water, when most desirable; elimination of freezing, adding to the safety of the structure; advantage of operation from the turbine room or nearby; and quiet water discharges downstream into a stilling pool, minimizing erosion.

No figures are given as to actual effect on capacity or output or cost of operation and earnings. It is stated that economy for heads below 16 ft. is questionable.

The Thurlow backwater suppressor type has been in operation at the Mitchell dam of the Alabama Power Co. on the Coosa River in Alabama for about three years, and its operation is reported to be most satisfactory. No trouble of any nature has developed due to changes from the conventional power-plant design. The normal head is 70 ft., and the results reported are:

1. As to physical operating conditions, not only can low-water operating heads be maintained, but a substantial increase above low tailwater head can be realized up until tailwater has reached about 25 ft. above normal; operation from one floor minimizes the crew; and the plant and sluicing equipment are all brought under one crane.

2. The analysis of cost of the suppressor type of plant in this case, where the whole width of channel is available for spillway, shows a material saving over the conventional plant, as a saving of over 400 ft. of spillway and excavation was effected.

3. As to economic results, it is claimed that in some of the studies it was found that the suppressor has the advantage of replacing a unit in an installation of as low as five units, but in other cases it has proved to be of little value, and this type of plant was not considered. Conditions vary to such an extent that the feasibility of using a backwater suppressor becomes a specific problem in every case. The power saved by the suppressor at Mitchell dam is regarded as so much saving in steam running, and is given credit as such.

The Moody ejector turbine was recently installed on two 12,000-hp. Francis turbines at the Island Falls plant of the Abitibi Electric Development Co., Ltd. In this type surplus water is discharged from the scroll case of the wheel through a cylinder gate directly into the throat of the draft tube. Although no full tests have been made on this installation, preliminary tests are reported to bear out the experimental tests made on models.

1. As to physical operating conditions, the use of the ejector maintains under the reduced head of 50 ft. the full power of the wheel under the rated head of 60 ft.

2. The cost of installation is little affected, as only slight modification is necessary in the waterways or the general arrangement and construction of plant.

3. As to economic results no information is available other than the statement that, based on the performance of the first two units, two more, practically duplicating the first two, are now being installed.

News in the Field of Power

Committee Makes Report on Museum of Engineering and Industry

Recommends Test of Merit and Validity of Movement Involving Probationary Program—Ewing To Head Trustees—H. F. J. Porter As Consulting Secretary

AT A meeting of the Board of Trustees of the National Museum of Engineering and Industry, held at the New York Headquarters of the American Institute of Electrical Engineers on January 20 the report of a committee on procedure, appointed in July, consisting of J. Waldo Smith, chairman, L. P. Alford, Arthur S. Dwight, F. A. Waldron and Gano Dunn was unanimously adopted.

The Committee on Procedure is firmly of the opinion that even so meritorious a movement as the establishing of a national museum of engineering cannot succeed without the enthusiastic co-operation of the four founder societies.

The committee finds that between the time of the report of the previous committee, and now, much commendable progress has been made by the movement, the objects of which make a strong appeal to the engineering profession and to the industrial interests and an informed public which has contacts with the engineering profession. There have been accumulated, not only in this interval, but from the beginning, a good will, a notoriety and a number of more or less tangible assets.

Recommends Test of Movement

The committee, moreover, is of the opinion that while the national engineering societies have never accepted any pecuniary responsibility for the movement, and, in appointing trustees to represent them on the governing body, have acted only with the view of aiding the movement, as distinguished from assuming the conduct of it, there has, from the very nature of the movement, come to exist in the minds of a considerable public within and without the national engineering societies an impression that it is more or less directly one of the projects, an impression to which the location of the office of the Museum movement in the Engineering Societies building has contributed.

The movement in a broad way may be regarded as a project to raise certain large sums of money organized by a membership association contributing small annual dues drawn principally from interested members of the engineering profession and their friends. But the ship can carry no more sail than its ballast warrants and unless the membership association underlying the movement is strong and active, the appeal for large funds will fail.

From all these considerations the committee is brought unanimously to recommend that a test be made of the merit and vitality of the movement, for a period of one or two years by the temporary abandonment of the considerable labors attendant upon the prosecution of a campaign for the raising of endowment funds, and a concentration upon the holding together and increasing of the membership association basis on which the movement now rests.

The above to be accompanied by a change in personalities acceptable to all parties which will insure to the probationary period the auspices of success.

If during this period the membership coheres and grows, the fund-raising activities can be resumed with good augury, but if under efficient administration, which the committee's report later recommends, the membership loses interest and dwindles, there will come about a natural as distinguished from a disruptive termination.

Probationary Program

Informal investigations indicate that under the nominations about to be recommended, the probationary program will be accepted with good will by all parties involved and an informal inquiry of the nominees indicates that if elected they will serve under the program herein outlined.

The committee therefore recommended:

(1) That the secretaryship of the National Museum of Engineering and Industry as at present organized be declared vacant.

(2) That a new secretaryship with executive authority appropriate to the conduct of a membership association be instituted to administer the affairs of the association, to which secretaryship it nominates Mr. Harrison W. Graver to take office immediately upon election by the Trustees. The clerical expenses of such secretaryship to be paid out of the current funds.

Ewing to Head Trustees

(3) That there be created a new office of Consulting Secretary to which it nominates Mr. H. F. J. Porter to take office immediately upon election. The Consulting Secretary will be without executive duties, need give but part of his time, but will be available to the President, to the Secretary and to the Board of Trustees for such information, advice and influence as will assist objects of the movement, which your committee feels without Mr. Porter's co-operation, would have to be promptly liquidated.

(4) That on account of his eminence in the field of patent law, his experience and Washington connections as Commissioner of Patents for a number of years, and his knowledge of and sympathy with the engineering profession and the objects of the Museum, Mr. Thomas Ewing be elected to the Presidency of the Trustees, an honor which Mr. Ewing has indicated he will accept if unanimously elected.

(5) That Messrs. Edward G. Acheson, L. H. Backeland, Charles F. Brush, Thomas A. Edison, Frank J. Sprague, Edward Weston and Orville Wright, who now hold the office of Vice-president of the Museum organization, be re-elected.

(6) That Mr. George E. Roberts, who now holds office of Treasurer, be re-elected.

The meeting of the Board was preceded by a membership meeting at which the Board of Trustees was reduced to 25 as follows: Mr. Thomas Ewing, L. P. Alford, B. C. Batcheller, George M. Bond, Nicholas F. Brady, F. H. Colvin, Gano Dunn, Col. A. S. Dwight, John R. Freeman, H. A. Gillis, Henry Goldmark, Frederick A. Halsey, Prof. Dugald C. Jackson, Luis Jackson, John W. Lieb, Fred R. Low, L. C. Marburg, E. S. Matthews, H. P. Merriam, H. F. J. Porter, Geo. E. Roberts, J. Waldo Smith, Dr. Elmer A. Sperry, F. A. Waldron.

The officers nominated in the report were formally elected.

A resolution expressing recognition of the interest and support of the retiring president, Samuel Insull, was unanimously adopted.

South Boston Station, Newly Equipped, Ready Soon

Extension of the South Boston power station is rapidly approaching completion. Additional space to the boiler house is being provided for two 20,750-sq.ft. boilers equipped for pulverized coal. The boilers, which are of the cross-drum type, are designed for 300 lb. operating pressure, but will be operated for the present at 200 lb. pressure.

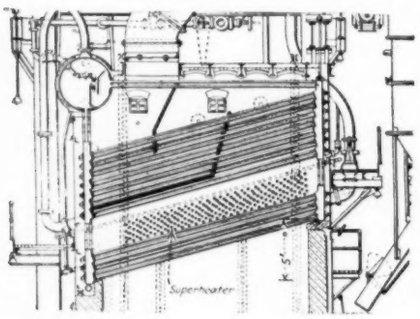
Six unit-type pulverizing mills, three for each boiler, will be placed in the firing aisle in front of the boilers. A traveling lorry, which is filled from an overhead steel bin having a capacity of 15 tons per running foot, will distribute the coal to the mills. Air heaters, placed, on the breeching directly above the boiler, are included in the new equipment. The furnaces, with the exception of the front wall, are completely water cooled.

The steel stack, which forms part of the improvement, is of the self-supporting type, no guying being necessary. It is 14 ft. 10 in. in diameter and approximately 355 ft. above the ground. The erection is being done by the construction division of the department of power.

Court Decides Infringement Suit in Favor of Babcock & Wilcox Co.

In an opinion filed Jan. 10, the United States Circuit Court of Appeals, Judges Hough, Manton and Mack, reversed the decision of the lower court and found in favor of the Babcock & Wilcox Co. against the Springfield Boiler Co. and the Superheater Co., in the suit involving infringement of patent rights as disclosed in the boilers of the Hell Gate Station. The infringement deals with the location of superheater and arrangement of baffles as contained in the Bell patents and reissue patent to Pratt, dated Oct. 18, 1921, claims 1, 2, 4 and 6. The last of these claims is here quoted from the decision, together with a cross-section of the boiler reproduced from the plant description in *Power*, May 9, 1922.

"A water-tube boiler having water compartments connected by longitudinal horizontally extending water tubes, a superheater having transversely extending tubes between the rows of water tubes and provided with bent or curved portions within the setting, and baffling for directing the products of combustion, said baffling having a horizontally extending portion among the water tubes over the superheater, and also having a portion extending upwardly and transversely of the water tubes above the superheater, said baffling forming an upward transverse pass from the gases which is narrower along the water tubes above the superheater than at the inlet to the water tubes below the superheater and to the superheater, and another baffle depending among the upper water tubes and extending transversely of them arranged to give the gases another transverse down and up pass through said upper water tubes."



Section of Hell Gate boiler

The court held that "this boiler was a substantial copy of appellants' Bell-Pratt type and of the blueprints which were submitted with their bid, except that a change was made in inserting the superheater tubes transversely of the water tubes instead of lengthwise of the water tubes."

In view of present boiler and furnace practice the decision is of far reaching importance to power engineers.

Funds for Oil Board

In requesting an appropriation from Congress of $50,000 to provide funds for the Federal Oil Conservation Board, available until June 30, 1928, the President evidently has in mind extending the investigations of this Board beyond those contained in the report submitted about two months ago.

Power Commissioners Assail Garrett Amendment

Cabinet members constituting the Federal Power Commission, headed by the Secretary of War, have reported adversely on the bill by Representative Garrett, of Tennessee, proposing to modify the existing definition of "navigable waters" and with respect to the requirements as to declarations of intention.

"It is the opinion of the Commission," say the secretaries, in their communication to the Interstate and Foreign Commerce Committee of the House, "that in all cases where federal authorization is necessary for power development in the streams of the United States, such authorization should be given under the provisions of the Federal Water Power Act; and that it would be a mistake to modify that act so as to withdraw from its provisions any prospective power developments, which if so withdrawn would require that authorization for their development be secured by special act of Congress, or through action by the War Department under prior legislation."

In regard to the provision of the Water Power Act providing for the filing of declarations of intentions the secretaries say:

"Since the provision now contained in the Federal Water Power Act makes possible power development on streams of doubtful status under conditions which protect the interests of interstate and foreign commerce, as well as those of the applicant, it is the opinion of the commission that the repeal of the provision, either outright or by indirection, would be a serious mistake.

"The expenditures involved in modern hydro-electric development are too large to permit of financing unless the right to continue use of the stream under known and fixed conditions is assured."

One of the provisions of the Garrett bill is that the Water Power Act is not to be construed or interpreted to authorize and empower the Federal Power Commission to "violate the sovereignty and property rights of the state" or the rights of riparian proprietors.

The secretaries state in their report that the Water Power Act does not authorize the violation of the sovereignty and property rights which the states possess under the constitution. They point out that the act gives no authority to grant a license until the requirements of the state laws have been complied with.

Largest Steel Mill Turbine Planned for Gary Plant

The largest turbine generator used by a steel mill will be installed by the Illinois Steel Co. at its Gary (Indiana) plant. This equipment, which will be furnished by the General Electric Co., will produce 30,000 kw. at 25 cycles, 6,600 volts, and will operate condensing.

A tendency of steel mills to use large prime movers is indicated, not only by this, but also by other similar installations to be made by other plants. The Tennessee Coal, Iron & Railroad Co. is soon to install two 20,000-kw. turbine-generators, and another unit of the same size will be installed by the Bethlehem Steel Co. at Sparrow's Point, Md.

Engineering Council Holds Annual Meeting

Adoption of a legislative program covering public works and a review of the conditions in industry governing safety and production were chief features of the two-day annual meeting of the American Engineering Council meeting at Washington, D. C., which closed Jan. 14.

Sessions were opened by Dean Dexter Kimball's presidential address on the progress and status of the engineering profession. Charles M. Schwab, president of the American Society of Mechanical Engineers, and Secretary Hoover, of the Department of Commerce, delivered notable addresses, which forecast new fields of usefulness for the engineering profession through the Council.

Of outstanding interest to all members of American Engineering Council was the progress being made in the study on safety and production. An evening session was devoted to this subject following which the Assembly was satisfied that the report was progressing so satisfactorily that its final acceptance could be left to the executive committee. The figures on this study show that the results will give a comprehensive cross section of American industry, since 18 of the basic industries of the country were well covered by 15 field engineers operating in the principal industrial centers of the country. The total number of companies represented in the survey will be practically 14,000, giving data for a total of 122,000 company years and involving a total in excess of 18,000,000 man years.

General support of several important pieces of legislation now before Congress were approved, such as the bill to employ engineers for consultation purposes in the Department of the Interior, the bill to increase and conserve the production of helium gas,—and several bills relating to the Patent Office.

All of the standing and special committees of Council were continued for next year, including representation on all of the boards and conferences in the work of which American Engineering Council participated last year.

A. W. Beresford and O. H. Koch were re-elected vice-presidents of Council for a two-year period. H. E. Howe was re-elected treasurer and L. W. Wallace, executive secretary, for the ensuing year.

The spring meeting of the administrative board of Council will be held in New York City, at a date to be determined later.

Shanghai University Exhibit

During the week of Oct. 10 the Chinese national holiday, more than one hundred thousand persons attended the engineering exhibit held by the Nanyang University of Shanghai.

Michigan Engineers To Meet for Second Conference

This year's Michigan Engineering Conference will be held Thursday and Friday, Feb. 3 and 4 at the Hotel Statler, Detroit. The first conference was held in Detroit in February of last year with nearly 900 registrants in attendance from all parts of the state and many from distant points. A fine program was offered during the two days of the gathering.

The 1927 conference plans to surpass last year's in many respects. Some features of the program, outlined below, contain topics for discussion that are of much interest to both engineers of the state and others.

"Our National Resources" will be the general subject of the afternoon meeting of Feb. 3, at which George H. Fenkell, superintendent and general manager of the department of water supply, Detroit, Mich., will preside. Dr. W. O. Hotchkiss, president of Michigan College of Mines; Prof. L. J. Young, department of forestry, University of Michigan, and Prof. J. O. Beatch, Michigan State College, will be the speakers.

"Engineering Research" will be featured in the evening by short addresses delivered by C. F. Kettering, General Motors Corp.; W. R. Whitney, General Electric Co.; Prof. H. C. Sadler, University of Mich., and Dr. Charles L. Reese, Dupont Manufacturing Co.

The sessions on Feb. 4 will include interesting talks and discussions on engineering education; the engineer and public health; safety, traffic and transportation, and the commercial and economic development of Michigan.

Pre-registration is urged because of the encouragement it gives to the committeee in charge, enabling it to proceed with confidence that support will not be lacking. Pre-conference headquarters have been established in the office of Detroit Engineering Society, 478 W. Alexandrin Ave., Detroit, where pre-registrations should be sent.

New Directors of American Brown Boveri Elected

American Brown Boveri Electric Corp. stockholders at their annual meeting held on Jan. 5 at the executive offices at 165 Broadway, New York, unanimously approved the election of directors by the voting trustees.

The following new members have been elected to the board of directors: Clifford Duckman; James I. Bush; Allen Curtis; William M. Flook; Edward N. Goodwin; Henry Lockhart, Jr.; Theodore G. Smith; Elisha Walker, and Frank R. Warton.

The older members, who with those just elected constitute the board of fourteen, are: Laurence R. Wilder; William V. Griffin; James Imbrie; William F. Ingold, and John J. Rudolf.

The new officers are as follows: William Flook, chairman of the executive committee; Frank R. Warton and Theodor Boveri, vice-presidents; Norman R. Parker, comptroller, and J. T. Wickersham, who has been acting secretary and treasurer, has now been appointed secretary and treasurer.

New and important financial interests have thus become identified with the American Brown Boveri Corp. through the election to the directorate of representatives of Blair & Co., Inc., the Central Union Trust Co., the Equitable Trust Co. and Curtis & Sanger.

Parker Coal Strike Control Bill Beaten

The House Commerce Committee refused Jan. 13 to report the Parker bill to give the executive branch of the government authority to act in coal strikes. The vote was 16 to 6.

The action was interpreted by Chairman Parker of the committee and the bill's author, as tabling all coal legislation for the season.

The measure, rejected after extended hearings, would have given the President, after a thirty-day suspension of work in the coal fields, authority to declare an emergency. The Interstate Commerce Commission then would have been authorized to regulate coal shipments through issuance of priority shipment orders. The Bureau of Mines also would have been called upon to investigate causes of the strike and compile a report on its finding.

The House of Representatives adopted by a vote of 276 to 82 the conference report on the $71,000,000 rivers and harbors authorizations bill. It provides for purchase of the Cape Cod Canal, improvement of the Illinois and Upper Missouri Rivers, and for work on a number of other projects in all sections of the country.

Jeffrey Manufacturing Co. Marks Fifty Years

Marking the fiftieth anniversay of its activity in the fields of coal-mining machinery, electric locomotives, elevating, conveying and crushing machinery, the Jeffrey Manufacturing Co. can count among its achievements for industrial progress a number of important developments in the handling, crushing, pulverizing and shredding apparatus.

Among the episodes in the concern's growth it might be recalled that in 1877, the company began the manufacture of a machine for cutting coal mechanically, on which new types of chain for power transmission were used. That machine, the first practical coal cutter, was destined to revolutionize the coal-mining industry and open the way for the development of chains for many industrial uses.

At about the same time a member of the company, then known as the Columbus Rolling Mills, came to the little one-room workshop of the Jeffrey company. Noticing several pieces of malleable roller and steel thimble roller chain lying on the floor, he inquired if they might not be used as a drive for the feed rolls in their mill.

These chains had been designed for use as drives on the Jeffrey coal cutters, but it was found that they worked equally well on the feed rolls. From this beginning the chain department of the Jeffrey company grew rapidly, and these two chains were soon being used for bucket elevators, conveyors and drives in several industries.

Lehigh Given $1,000,000 for Laboratory

A gift of $1,000,000 for the erection of an electrical and mechanical engineering laboratory at Lehigh University from James W. Packard, of Warren, Ohio, graduate in the class of 1884 and originator of the Packard motorcar, was announced at a recent meeting of the board of trustees of Lehigh University.

The new laboratory will provide every modern facility for instruction and research in the applied sciences.

Modern electrical and mechanical machinery from large boilers, refrigerating machines, pumps and compressors, down to the most delicate instruments for precise measurements will be included in the equipment.

Reports Muscle Shoals Revenue for 1926

During the calendar year 1926 there was sold to the Alabama Power Co. from the hydro-electric power plant at Wilson Dam, a total of 428,265,885 kw.-hr. of electric power.

The net operating revenue to the government from the Wilson Dam plant and the steam plant for the year ending Dec. 31, 1926, was as follows:

Receipts from sale of power totaled $872,617.47; maintenance and operation cost $173,777.53, making a net operating revenue of $698,839.94. The rental of the steam plant under lease to the Alabama Power Co. was $120,000; and receipts for power generated in steam plant figured at $40,370.73. The net revenue from the steam plant was, therefore, $160,370.73. The total net operating revenue for Muscle Shoals plants is put at $859,210.67.

Obituary

Charles Waite Waller, formerly vice-president and general manager of the Great Western Power Co., San Francisco, and active in electrical power development for many years, and for fifteen years associated with General Electric Co. interests, died Jan. 19, at his home, 270 Park Avenue, New York City.

Mr. Waller, who was fifty-six, was vice-president in charge of finance of the United Hotels Company of America and a director and member of the executive committee of the Murray Hill Trust Co. at the time of his death.

Personal Mention

John W. Childress, head of the Emerson Pump & Valve Co., has been nominated a member of the newly created public utility commission for the District of Columbia.

C. H. Garcelon, formerly manager of the small motor engineering of the East Pittsburgh works of the Westinghouse Electric & Manufacturing Co., has been appointed manager of engineering of the works. As manager, he will have administrative charge of all engineering at this plant.

James Lyons has been promoted to the post of supervising the production department of the Westinghouse Electric & Manufacturing Co., South Philadelphia works.

Alfred Voysey has been appointed to the position of assistant general superintendent of the South Philadelphia works of the Westinghouse Electric & Manufacturing Co.

J. G. Coutant, who has been for the last three years consulting and combustion engineers for the Furnace Engineering Co., manufacturers of Simplex pulverizers and water floor furnaces, has opened an office as consulting fuel engineer at 26 Cortlandt St., New York City. Mr. Coutant, who has had a wide experience applying pulverized fuel to boilers and industrial furnaces both here and abroad, will now specialize in reports and engineering assistance on fuel problems and the increased capacity of boilers and industrial furnaces.

Society Affairs

The A.S.M.E., Metropolitan Section, will hold a joint meeting with the Power Division of the Society at the Engineering Societies Building, 29 West 39th St., New York City, on the subject of advanced methods in power generation the evening of Jan. 31. Bert Houghton, Brooklyn Edison Co., will be the speaker.

Business Notes

The Rix Co., compressed air engineers, whose main office and factory is located in San Francisco, have appointed J. K. Haigh as Los Angeles branch manager.

William Ganschow Co., Chicago, announces the appointment of Curtis & Burgess, 1432 Syndicate Trust Bldg., St. Louis, Mo., as representatives in the St. Louis district. Curtis & Burgess are replacing O. T. Barnidge.

The Worthington Pump & Machinery Corp. has purchased the Harris Air Pump Co., Indianapolis, Ind., for some years among the foremost manufacturers of air-lift systems and air-lift pumps. The purchase was outright and includes patents, drawings, patterns and good will.

Harry E. Miller, for thirty-seven years with the Westinghouse Electric & Manufacturing Co., has been appointed by that company as works manager of the Newark plant. Prior to this promotion Mr. Miller was successively assistant superintendent, superintendent and assistant works manager of the plant.

The Yeomans Brothers Co., 1433 Dayton Street, Chicago, manufacturer of pumping machinery, announces the appointment of the Purdy & Henderson Trading Co., Havana 55, esquina a Empedrado, Havana, Cuba, as sales representatives for that territory. They will handle the complete Yeomans line of pumping equipment.

The American Hammered Piston Ring Co., of Baltimore, has enlarged its sales organization, and secured the services of John W. Henderson, who was formerly with the Ferris-Simpson Co., of Dallas, Tex. Mr. Henderson will sell American "Hammered" piston rings in Texas and part of Louisiana.

Coming Conventions

American Boiler Manufacturers Association will hold meeting at Cleveland, Ohio, Feb. 11; A. C. Baker, secretary and treasurer, 801 Rockefeller Bldg., Cleveland, Ohio.

American Institute of Electrical Engineers. Winter convention at New York City, Feb. 7-10; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Heating and Ventilating Engineers. Annual meeting at St. Louis, Mo., Jan. 25-28; A. V. Hutchinson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Spring meeting at White Sulphur Springs, W. Va., May 23-26. Calvin W. Rice, secretary.

Chicago Power Show, at Chicago, Feb. 15-19. G. E. Pfisterer, managing director, 53 West Jackson Blvd., Chicago.

Engineering Institute of Canada. Richard John Durley, secretary, 176 Mansfield St., Montreal, Que. The forty-first annual general and general professional meeting will be held at Montreal on Thursday, Jan. 27, and will be adjourned to reconvene at Quebec City at the Chateau Frontenac Hotel Feb. 15, continuing on the two succeeding days.

Michigan Engineering Conference at Hotel Statler, Detroit, Mich., Feb. 3 and 4. E. L. Brandt, secretary.

Midwest Power Conference, at Chicago, Feb. 15-18. Sessions will be held in the Coliseum concurrently with the Chicago Power Show; G. E. Pfisterer, secretary.

National Association of Stationary Engineers—Annual convention at Los Angeles, Aug. 22-27.

National Association of Stationary Engineers. New England States convention at Portland, Me., June 17-18. Thomas H. Clark, president, Worcester, Mass.; Robert Johnson, secretary, 65 Charlotte St., Worcester, Mass.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting at Nashville, Tenn., during second week of June.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Annual convention at Atlantic City, week beginning June 6.

National Marine Engineers' Beneficial Association. Fifty-second annual convention at the Hotel Franklin Square, Washington, D. C., Feb. 14-19. Albert L. Jones, secretary-treasurer.

M. B. Urquhart, who has been Northwestern manager for the Keystone Lubricating Co. for the last twenty years, assumed, Jan. 1, the Western management of the Philadelphia Grease Manufacturing Co., of Philadelphia, with offices and warehouses in the Ideal Building, Denver, Colo., and 144 South Fifth St., Salt Lake City, Utah.

The Quigley Furnace Specialties Co., Inc., of New York, manufacturers of Hytempite, Quigley refractory gun, Triple-A solutions, etc., reports that George A. Russ has joined the company's service staff to cover the Central South and South Atlantic States. Cooperating with all Quigley agents throughout the South, Mr. Russ is making his headquarters at Atlanta, Ga.

The Allen-Bradley Co., Milwaukee, Wis., manufacturer of electric controlling apparatus, has placed in charge as district manager of the new Detroit office J. A. White, formerly manager of the electrical department of the Charles A. Strelinger Co. Prior to the former connection Mr. White was associated with the industrial sales department of the Westinghouse Electric & Manufacturing Co., East Pittsburgh.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Jan. 17 1927
Pool 1	New York	$3.00@$3.50
Smokeless	Boston	2.50
Clearfield	Boston	2.15@ 2.70
Somerset	Boston	2.30@ 2.85
Kanawha	Columbus	1.75@ 2.00
Hocking	Columbus	1.75@ 2.00
Pittsburgh	Pittsburgh	2.00@ 2.25
Pittsburgh gas slack	Pittsburgh	1.60@ 1.70
Franklin, Ill.	Chicago	2.50@ 2.75
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.25@ 1.60
S. E. Ky.	Louisville	1.75@ 2.00
Big Seam	Birmingham	1.75@ 2.25
Anthracite Gross Tons		
Buckwheat No. 1.	New York	2.50@ 4.25
Buckwheat No. 1.	Philadelphia	2.50@ 3.25
Birdseye	New York	1.35@ 2.00

FUEL OIL

New York—Jan. 20, light oil, tank-car lots; 28@34 deg. Baumé, 5¾c. per gal.; 36@40 deg., 6¼c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Jan. 13, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.02½ per bbl.; 26@28 deg., $2.07½ per bbl.; 28@30 deg., $2.12½ per bbl.; 30@32 deg., $2.17½ per bbl.; 32@36 deg., gas oil, 6.2c. per gal.; 38@40 deg., 7.4c. per gal.

Pittsburgh—Jan. 11, f.o.b. local refinery; 30@34 deg., fuel oil, 6½c. per gal.; 36@40 deg., fuel oil, 6¾c. per gal.

Philadelphia—Jan. 14, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $1.725@$1.785 per bbl.

Cincinnati—Jan. 10, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Jan. 18, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.27½ per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.65.

Boston—Jan. 18, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.5c. per gal.; 28@32 deg., 5.8c. per gal.

Dallas—Jan. 10, f.o.b. local refinery, 26@30 deg., $1.73 per bbl.

Trade Catalogs

Instruments for Steam Power Plants—The Taylor Instrument Companies, Rochester, N. Y. As Catalog Part I of Tycos instruments for steam power plants the present illustrated and tabulated issue covers a complete line of equipment.

Welding Wire—The John A. Roebling's Sons Co., main office and works, Trenton, N. J., in a pocket-size illustrated booklet describes Roebling welding wire for acetylene gas welding and for electric arc welding. Roebling (American iron) welding wire for acetylene gas welding is 99.75 per cent pure iron Standard material, is copper coated to distinguish it readily from wire for electric welding and is furnished, for quick shipment, in eight diameters; the standard length is 36 in. Wire for automatic electric welding, in long lengths on reels or in coils must be smooth, cylindrical, free from surface imperfections, kinks and mechanical injuries in order to feed freely in process of welding.

Welding and Cutting Apparatus — The Alexander Milburn Co., 1416-1428 West Baltimore St., Baltimore, Md., has issued the latest vest-pocket edition of catalog No. 17-E on Milburn welding and cutting apparatus, including regulators and generators. Upon request the company will gladly send copies to interested readers.

Valves—W. H. Nicholson & Co., manufacturers of machinery and steam specialties, Wilkes-Barre, Pa. New bulletin No. 127 deals with Nicholson three- and four-way valves for air, steam or water on pressures up to 500 pounds.

Protective Coatings Against Corrosion — The Dampney Company of America, Boston, Mass., in bulletin No. 1092 treats of corrosion to boiler tubes and drums, steel-tube economizers, feed water heaters and steam turbines. Apexior, the trade name of a protective coating manufactured by the Dampney Company of America, is a grey-black liquid, similar in consistency and appearance with paint. Soon after applied a smooth, hard, continuous protective coating is left on the metal surface.

Force Feed Lubricators—The Hills-McCanna Co., 2025 Elston Ave., Chicago, Ill., has brought out a new booklet on force feed lubricators. In addition to the company's usual line of steam specialties for power plants, a line of chemical proportioning pumps, described briefly on the last page of the booklet, should be noted. This class of equipment is designed for the metering of boiler compounds, water softening chemicals and various commercial chemicals entering into the manufacturing process in the chemical and oil industries.

Steel Grating and Flooring — The Blaw-Knox Co., manufacturers of steel products, Pittsburgh, Pa., now offers an original design in steel grating and flooring. This grating is called "Security Grating" because of the fact that the security of the user in his purchase being emphasized by the fact that he has obtained the steel grating in which the full value of the metal is utilized without the use of bolts or slots, one in which there is no weakening of the structure by riveting, and a grating which is strictly "non-slip" in every sense of the word.

Climax Engines. The Climax Engineering Co., Clinton, Iowa, has issued two new bulletins covering the application of its Climax "Trustworthy" engines to various types of power. Bulletin K describes power units for driving sand pumps and rock crushers, while Bulletin O covers the use of power units for portable sawmills. In these bulletins tables are given showing the power requirements for each industry, with a list of engine models which apply to each set of conditions. The bulletins are illustrated by scenes showing the Climax engines at work in each of the various fields covered. Copies will be sent on request to anyone interested.

New Plant Construction

Ark., Little Rock—Standard Ice Co., 114 South Main St., will build an ice plant at 1101 Summitt St. by day labor. Estimated cost $40,000.

Calif., Long Beach—Southern California Edison Co., 306 West 3rd St., Los Angeles, awarded general contract for the construction of a steam power plant here to Stone & Webster, Byrne Bldg., Los Angeles. Estimated cost first unit $5,000,000.

Conn., Norwich—Connecticut Co., Greenville, awarded contract for the construction of a sub-station here to P. F. Sweeney, 25 Chestnut St., Norwich. Estimated cost to exceed $40,000.

Conn., Norwich — Norwich State Hospital, State Bd. of Health, State House, Hartford, plans extensions and improvements to power unit, here. Estimated cost $65,000. Architect and engineer not selected.

Conn., Norwich—Standard Oil Co., Forest St., is having plans prepared for the construction of a boiler house. Estimated cost $100,000. Private plans.

Del., Wilmington—P. S. Hospital Association, Chestnut and Rodney Sts., will receive bids until Apr. 1, for the construction of a hospital including refrigeration system, boilers, pumps, elevators, etc. on Broome St. Estimated cost $500,000. York & Sawyer, 100 East 42nd St., New York, N. Y., are architects. R. P. Schoenijahn, Ind. Tr. Bldg., Wilmington, Del., is engineer.

Ill., Chicago—Delaware Place Building Corp., J. A. Armstrong, 137 North Dearborn St., Archt., awarded contract for masonry, etc. for a 16 story apartment at 16-22 East Delaware Pl. to J. H. Johnson, 200 East Erie St. Estimated cost $1,000,000.

Electrical refrigeration, high speed elevators, etc. will be installed.

Ill., Chicago—H. W. Rubloff, 10 South La Salle St., awarded contract for the construction of a 7 story apartment on Sherwin Ave. to Fitzgerald Construction Co., 105 West Monroe St. Estimated cost $750,000. Refrigeration system, elevators, etc. will be installed.

Ill., Chicago—Wells-Van Buren Building Corp. c/o D. S. Klafter, 64 West Randolph St., Archt., awarded contract for the construction of a 16 story office and stores building to L. Balkin, 1852 West Austin Ave. Estimated cost $1,500,000.

Steam heating system will be installed.

Ill., Savanna—Commissioners of Savanna & York Drainage Dist., F. J. Stransky, Comr., will receive bids until Feb. 5, for the installation of one 2,000 g.p.m. and one 1,000 g.p.m. automatic pumping units including small pump house, transmission lines, etc. in present pumping station. C. H. Young, Muscatine, Ia., is chief engineer.

Ky., Louisville—F. G. Breslin, c/o Breslin Sand Co., 32nd and Market Sts., will receive bids until Feb. 1 for the construction of a 15 story office building including steam heating and refrigeration systems, boilers, elevators, etc. on Broadway. Estimated cost $1,500,000. Joseph & Joseph, Francis Bldg., are architects.

Mass., Bedford—U. S. Veteran's Bureau, Arlington Bldg., Washington, D. C., will receive bids until Mar. 1, for the construction of a group of hospital buildings including boiler plant, ice-making and refrigeration plant, etc. at U. S. Veteran's Hospital, here.

Mass., Somerset—Town, A. J. Eagen, Chn., of Committee, is receiving bids for the construction of a waterworks system and pumping station. Estimated cost $500,000. F. A. Barbour, 1119 Tremont St., Boston, is engineer.

Mich., Detroit—First National Bank, Woodward St. and Cadillac Sq., is having plans prepared for the construction of a 16 story office building including steam heating equipment on Cadillac Sq. A. Kahn, 1000 Marquette Bldg., is architect.

Mich., Flint—F. P. Kottenstette, is having plans prepared for the construction of a 6 story hotel including steam heating boiler and equipment, elevator, etc. Estimated cost $500,000. C. N. Agree, 1140 Book Tower, Detroit, is architect.

Minnesota—North States Power Co., R. F. Pack, V. Pres., 15 South State St., Minneapolis, plans extensions and improvements during 1927 including additions to power facilities for steam plants and increasing power in sub-stations at Twin City, construction of a new gas plant at Faribault, also addition to distribution plant and improvements in telephone exchange at Minot, N. D., etc. Total estimated cost $4,000,000. Private plans.

Minn., New Ulm—City plans the installation of a new 900 kw. unit in electric light and power plant. Estimated cost $50,000.

Minn., North Mankato (Mankato P. O.) —City will receive bids until Jan. 31 for drilling two or three 12 in. tubular wells, 60 ft. deep; bids later for furnishing and installing pumps. Total estimated cost $20,000.

Minn., Thief River Falls—City plans to rebuild electric power plant including power house, complete equipment, etc. to double the present capacity of 350 hp. Estimated cost $50,000. Jacobson Engineering Co., 420 Oak Grove St., Minneapolis, is engineer.

Miss., Pelahatchee—City will receive bids until Feb. 8, for waterworks improvements including well, 50,000 gal. reservoir, pump house, pumping equipment, two 250 and 750 g.p.m. centrifugal pumps, etc. Estimated cost $40,000. W. D. Montgomery, Jackson, is consulting engineer.

Neb., Auburn—Jerpe Storage Co., 12th and Douglas Sts., Omaha, plans the construction of a cold storage plant, here. Estimated cost $50,000. Architect not selected.

N. J., Paulsboro—Vacuum Oil Co., awarded contract for the construction of a power plant and boiler house to Stone &

Webster, 120 Broadway, New York, N. Y. Estimated cost $2,000,000. Pumps, boilers, etc. will be required.

N. Y., Andover—Niagara Lockport & Ontario Power Co., Lafayette Bldg., Buffalo, plans the construction of addition to electrical plant and extension of transmission lines. Estimated cost $300,000. Private plans.

N. Y., Brooklyn—Brooklyn Union Gas Co., 126 Remsen St., plans the construction of a generating station at 406 Gardiner St. Estimated cost $600,000. Private plans.

N. Y., Brooklyn—Rubel Coal & Ice Co., 197 Glenmore Ave., will build an ice plant at 2223 Utica Ave. Estimated cost $85,000. E. M. Adelsohn, 350 Stone Ave., is architect and engineer. Work will be done by separate contracts.

N. Y., Dansville—The Power Specialty Co., 111 Broadway, New York, plans the construction of a coal pulverizer plant here. Estimated cost $175,000. Equipment will be required.

N. Y., Lockport—Niagara Falls Power Co., Canal Basin, Niagara Falls, plans the construction of a power unit between Lockport and Lake Ontario. Estimated cost $500,000. Private plans.

N. Y., Middle Village—Metropolitan Resources, 111 Broadway, New York, awarded contract for the construction of a power house here, to Caye Construction Co., 356 Fulton St., Brooklyn. Estimated cost $250,000.

N. Y., New York—Billingsley Realty Co, Inc., c/o Moore & Landseidel, 148th St. and Third Ave., Archts., is having plans prepared for the construction of a 15 story apartment including steam heating system, elevators, etc. on Pelham Parkway. Estimated cost $2,500,000.

O., Canton — County Comrs. plan the construction of a tuberculosis hospital including heating plant at Louisville and Harrisburg Rd. Estimated cost $500,000. A. L. Thayer, New Castle, Pa., is architect.

O., Toronto—The Ohio River Edison Co., is having plans prepared for the installation of a 33,000 kw. unit with boilers and auxiliaries in its Toronto Super Power Station. Stevens & Wood Inc., 120 Broadway, New York, N. Y., are engineers.

Okla., Sapulpa—City Council, is having preliminary plans prepared for the construction of a new electric light plant including a 2,000 hp. Diesel engine. Estimated cost $300,000. Engineer not selected.

Okla., Talihina—Dierks Lumber Co., 700 Gates Bldg., Kansas City, Mo., is having preliminary plans prepared for the construction of a hydro-electric plant and impounding reservoir on Steep Creek near here. Estimated cost $100,000. Engineer not selected.

Oregon—California Oregon Power Co., P. O. Crawford, V. Pres. and Gen. Mgr., subsidiary of the Standard Gas & Electric Co., 454 California St., San Francisco, Calif., awarded contract for the construction of a hydro-electric development on the north fork of the Rogue River in Southern Oregon, including power plant, initial capacity, 22,000 hp. ultimate total capacity 66,000 hp., diversion dam, step-up sub-station, 980 ft. penstock, transmission line, etc., to Byllesby Engineering & Management Corp., 231 South La Salle St., Chicago, Ill. Estimated cost $3,250,000.

Pa., Rouseville—Pennzoil Co., Oil City, awarded contract for the construction of addition to plant including boiler house, etc. here, to The Rust Engineering Co., 311 Ross St., Pittsburgh. Estimated cost $250,000.

Tenn., Chattanooga — Chattanooga Terminal Warehouses, Inc., Z. W. Wheland, Pres., plans the construction of a general storage and cold storage warehouse on Central Ave. Estimated cost $750,000.

Tex., Amarillo—Badger Ice Co., awarded contract for the construction of an ice plant to McHancock Construction Co., 1018 West 6th St. Estimated cost $37,500.

Tex., Crystal City—City plans an election to vote $50,000 bonds for the construction of a waterworks system including pumping equipment, 100,000 gal. tank on tower, etc.

Tex., Dalhart—Dalhart Water Co., is having plans prepared for waterworks improvements including pumping unit, mains, etc. Estimated cost $15,000. Private plans.

Tex., Levelland—City plans waterworks improvements including 50,000 gal. reservoir, pumping plant, one 250 g.p.m. and one 500 g.p.m. motor driven centrifugal pumps, 150 ft. head, 2,200 v., 3 ph., 60 cycle, tank on tower, etc. Estimated cost $50,000. Hawley & Roberts, Box 1115, Lubbock, are engineers.

Tex., Olmito—A. Parker Securities Co., Brownsville, is receiving bids for the construction of a waterworks system including pumping unit, etc. here. Estimated cost $120,000. Private plans.

Va., Grove Hill (mail Shenandoah)—Shenandoah River Power Co., Shenandoah, had surveys made for the construction of a hydro-electric plant including dam 17 ft. high here.

Va., Hampton—Newport News & Hampton Railway, Gas & Electric Co., C. D. Porter, V. Pres. and Gen. Mgr., Newport News, is having plans prepared for the construction of a new ice plant at power house here to replace 100 ton plant now in use. Estimated cost $300,000.

Wis., Madison—University of Wisconsin, J. S. Phillips, Bus. Mgr., plans the construction of an electrical laboratory. Estimated cost $395,000. Architect not selected.

B. C., Vancouver—Vancouver Ice & Cold Storage Co., 11 Gore Ave., awarded contract for the construction of a cold storage plant, to E. J. Ryan Contracting Co., 445 Granville St. Estimated cost $200,000.

Ont., Blenheim — Town passed bylaw authorizing the expenditure of $85,000 for waterworks improvements including reservoir, pump house, electric pumps, etc. Wynne-Roberts Son & McLean, Metropolitan Bldg., Toronto, are engineers.

Equipment Wanted

D. C., Washington—A. L. Flint, General Purchasing Officer of the Panama Canal, will receive bids until Feb. 11, for a Diesel electric hydraulic dredge and equipment.

Fla., Jacksonville—Jacksonville Traction Co., prices and catalogs for repair parts for a Webster Star vacuum feed water heater, purifier and filter No. 8497.

Ill., Chicago—Dept. of Public Works, A. A. Sprague, Comr., City Hall, will receive bids until Jan. 26 for constructing and installing the entire electrical equipment for a Double-Leaf Trunnion Bascule Bridge over the Chicago River at North La Salle St.

Ill., Savanna—Commissioners of Savanna & York Drainage Dist., F. J. Stransky, Comr., will receive bids until Feb. 5 for one 2,000 g.p.m. and one 1,000 g.p.m. automatic pumping units. C. H. Young, Muscatine, Ia., is chief engineer.

Ia., Jewell—City, C. V. Campbell, will receive bids until Jan. 28 for deep well pump, single stroke of 80 g.p.m. at 30 crank r.p.m. or double stroke of 100 g.p.m. at 30 crank r.p.m., motor 220 v. 1,200 r.p.m. 10 hp., 3 ph., 10 hp. single ph., 15 hp., 3 ph. and 15 hp. single ph., 75,000 gal. tank on tower, etc. for waterworks improvements. Henningson Engineering Co., 12th and Harney Sts., Omaha, Neb., is engineer.

Mich., Detroit—W. Atkins, 14290 Meyers Rd., prices and catalogs for firebrick and refractories.

N. J., Paterson—United Laundry Corp., W. Note, 19-21 Mill St., prices and catalogs on oil separator to be installed on a 5 in. line and must separate 40 lbs. of steam per min. including companion flanges.

Miss., Pelahatchie — City will receive bids until Feb. 8 for pumping equipment including two 250 and 750 g.p.m. centrifugal pumps. W. D. Montgomery, Jackson, is consulting engineer.

N. J., South River—Bd. of Public Works, plans the installation of a 1200 hp. full Diesel oil combustion engine in power house. Estimated cost $120,000.

Tex., Dallas—City, M. G. Jones, Secy., will receive bids until Jan. 28, for one 1,200 g.p.m. booster pump, one 200 hp. and one 100 hp. motors, etc. E. A. Kingsley is city engineer.

Tex., Eastland—Eastland Mineral Water Co., K. C. Ferguson, Pres., 204 Exchange Bank Bldg., is in the market for heating plant and air cooling equipment for bath and clinic building.

Utah, Nephi—Parks & Anderson, prices and catalogs for electrical instruments and relays, also instrument transformers.

Wis., Milwaukee—A. H. Friese, 610 Sycamore St., prices and catalogs for electric arc welders.

Alta., Calgary — Electrical Engineers Ltd., plans the installation of a turbine plant including boilers, pumps, turbines, generators and condensers, 3 ph., 2,200 v., 60 cycle, 500 and 300 kva.

Ont., Toronto—City, T. Foster, Mayor, City Hall, will receive bids until Feb. 8, for the construction of two 30,000,000 gal. electric centrifugal pumping units. Estimated cost $20,000. R. C. Harris, City Hall, is engineer.

Porto Rico, Mayaguez—J. F. Gonzales, P. O. Box 454, prices and catalogs for a 1 ton ice making plant, complete, to have possible feature of making an increase in capacity up to 2 ton, fuel oil burners and fuel oil burning systems, adaptable to 150 hp. return tubular boiler and 350 hp. Sterling type boiler.

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